LAKE CLASSIFICATION REPORT FOR LOWER CAMELOT LAKE, UPPER CAMELOT LAKE AND CAMELOT CHANNEL

Presented by Reesa Evans, CLM, Lake Specialist
Adams County Land & Water Conservation Department
P.O. Box 287, Friendship, WI 53934

NOVEMBER 2008

CLASSIFICATION REPORT FOR CAMELOT LAKES

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background Information about the Camelot Lakes

The Camelot Lakes are located in the Town of Rome, Adams County, WI (T20N, R6E), in the south central part of Wisconsin. They are part of a series of lakes commonly called "Tri-Lakes". Lower Camelot Lake is the first lake in the series, where Fourteen Mile Creek enters. Lower Camelot Lake is 260 surface acres, with a maximum depth is 24 feet and an average depth of 8 feet. Spring Branch Creek enters Upper Camelot Lake. Upper Camelot Lake has 191 surface acres, with a maximum depth of about 25 feet and an average depth of 8 feet. A channel connects Lower Camelot Lake to Upper Camelot Lake. There is a public boat ramp located on southwest side of Lower Camelot Lake owned by The Adams County Parks Department. The dams that impound these streams & form the lakes are owned and maintained by Adams County. The lake shores on both lakes are heavily developed.

The primary soil type in the both the ground and surface watersheds is sand. However, directly around the two Camelot Lakes, the soil is mostly sand. Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required. Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

Land Use in the Camelot Lakes Watersheds

Both the ground and surface watersheds for the Camelot Lakes are large. The two most common land uses in both the ground and surface watersheds are agriculture and woodlands

The Camelot Lakes have a total shoreline of 18 miles (95,040 feet). The bulk of the lakeshores are in residential use, with several beach clubs also located on the lakes. Some of the areas near the shores are steeply sloped, some are quite flat. Shores tend to be soft sand and subject to easy erosion.

Only about 25% of Upper Camelot Lake's shore has native vegetation at the water line; 63.5% of the shore is covered with traditional cultivated lawn, hard structure (piers, seawalls, etc.) and rock riprap. Lower Camelot Lake's shore has even less native cover (23%) and has 60% of the "developed" shore of lawn/hard structure/rock riprap. The lake shores also have from 11% to 15% sand or active erosion. The Camelot Channel has only 11% native vegetation at the shore, with 75.5% of the shore being "developed."

The Adams County Shoreline Ordinance defines 1000' landward from the ordinary high water mark as "shoreland". Under the ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

A 2004 shore survey showed that very few of the shores on these lakes and channel had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with significant hard structures (piers, patios, etc.), mowed lawns and/or insufficient native vegetation or at the shoreline to cover 35 feet landward from the water line.

Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are many of shores on both Camelot Lakes.

Adequate buffers on the Camelot Lakes and channel in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, such as pointd that extend into the lake, shaping, revegetating and protecting the shores will be necessary to prevent further erosion.

Water Testing Results

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on the Camelot Lakes.

Overall, they were determined to be mildly eutrophic lakes with poor to good water quality and clarity

Measuring the phosphorus in a lake system provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth. The 2004-2006 summer average phosphorus concentration in Lower Camelot Lake was 23.17 micrograms/liter. It was 16.92 micrograms/liter on Upper Camelot Lake. These averages are under the 30 micrograms/liter level recommended to avoid nuisance algal blooms. This concentration suggests that these lakes are not likely to have nuisance algal blooms from excessive phosphorus.

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Lower Camelot Lake in 2004-2006 was 5.54 feet. This is fair water clarity. Upper Camelot Lake had good water clarity with an average of 6.19 feet.

Chlorophyll-a concentration provides a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. The 2004-2006 growing season (June-September) average chlorophyll-a concentration in Lower Camelot Lake was 15.53 micrograms/liter and in Upper Camelot Lake was 11.9 micrograms/liter, far lower than the state average of 65 micrograms/liter for impoundments.

Both lakes had water testing results showing "hard" water with an average of 184 milligrams/liter $CaCO_3$ for Lower Camelot Lake and 126.4 milligrams/liter for Upper Camelot Lake. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

A lake with a neutral or slightly alkaline pH like these two lakes is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at either Camelot Lake, since the surface water alkalinity averages 126.4 milliequivalents/liter for Lower Camelot Lake and 119.2 milliequivalents/liter for Upper Camelot Lake. The pH levels from the bottom of the lake to the surface hovered between nearly 7 and 8, alkaline enough to buffer acid rain.

Some of the water quality testing at these lakes showed areas of concern. The presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level found in Lower Camelot Lake during the 2004-2006 testing period was 11.16 milligrams/liter and in Upper Camelot was 11.7 micrograms/liter, elevated substantially above the natural level of 3 milligrams/liter for chloride in this area of Wisconsin. Prior studies also found elevated chloride levels in the Camelot Lakes. The source of this ongoing elevation needs to be identified and the elevation reduced.

The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Lower Camelot Lake combination spring levels from 2004 to 2006 averaged 1.39 milligrams/liter, above the .3 milligrams/liter predictive level for nitrogen-related algal blooms. Upper Camelot Lake, at 1.54 milligrams/liter, was also above the recommended level. These elevations suggest that some of the algal blooms on the Camelot Lakes may be at least partly nitrogen-related. This issue should be further investigated.

In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Both Camelot Lakes had elevated sulfate levels, with Lower Camelot Lake averaging 28.83 milligrams/liter and Upper Camelot Lake averaging 33.7 milligrams/liter. These are both above the level for hydrogen sulfate formation, and Upper Camelot Lake's level is above the health advisory level. This is also an area of concern to be further investigated.

The average calcium level in Lower Camelot Lake's water during the testing period was 43.35 milligrams/liter. The average Magnesium level was 17.84 milligrams/liter. Average calcium for Upper Camelot Lake was 38.85 milligrams/liter and average magnesium was 16.9 milligrams/liter. All of these are low-level readings. Both sodium and potassium levels for the Camelot Lakes are very low: the average sodium level was 3.1 milligrams/liter for both Camelot Lakes; the average potassium reading was 2.78 milligrams/liter for Lower Camelot Lake and 2.6 milligrams/liter for Upper Camelot Lake.

Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. All of the Camelot Lakes' turbidity readings were below 5 NTU.

<u>Phosphorus</u>

Like most lakes in Wisconsin, the Camelot Lakes are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other water quality aspects.

The total phosphorus (TP) concentration in a lake is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For a man-made lake like the Camelot Lakes, a total phosphorus concentration below 30 micrograms/liter tends to result in few nuisance algal blooms. Both Camelot Lakes' growing season (June-September) surface average total phosphorus levels were under that limit, suggesting that phosphorus-related nuisance algal blooms may occur only rarely.

Land use plays a major role in phosphorus loading. The land uses around these lakes that contribute the most phosphorus are agriculture and septics. Some phosphorus deposition cannot be controlled by humans. However, some phosphorus (and other nutrient) input can be decreased or increased by changes in human land use patterns. Practices such as shoreland buffer restoration along waterways; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Such practices need to be implemented in all of the Tri-Lakes Watersheds in order for a significant impact on phosphorus reduction to occur.

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve water quality by .6 to 7.9 micrograms/liter. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to improve, maintain and protect Camelot Lakes' health for future generations.

Aquatic Plant Community

The aquatic plant communities in the Camelot Lakes and the Camelot Channel are characterized by plants that can handle high levels of disturbance. Disturbances include invasions of exotic species, boat traffic, shoreline development, harvesting and past herbicide treatments.

Of the 23 species found in Lower Camelot Lake, 21 were native and 2 were exotic invasives. In the native plant category, 8 were emergent, 1 was a floating-leaf plant, and 12 were submergent species. Two exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Phalaris arundinacea* (Reed Canarygrass) were found. Filamentous algae were found at 8.22% of the sample sites in 2006 and at 16.44% of the sites in 2000.

Najas flexilis and *Vallisneria americana* were the most frequently-occurring plants in Lower Camelot Lake in 2006 (each with 46.58% frequency), closely followed by *Chara* spp at 42.47% occurrence frequency. In 2000, *Chara* spp. was the most-frequency occurring species. No species reached a frequency of 50% or greater in the lake overall in either 2000 or 2006.

Vallisneria americana was also the densest plant in 2006 in Lower Camelot Lake, with a mean density of 1.36 (on a scale of 1 to 4). In the lake overall, none of the aquatic vegetation had a mean density of over 2.0, meaning none occurred at more than average density, in either 2000 or in 2006.

Based on dominance value, *Vallisneria americana* was the dominant aquatic "plant" species in Lower Camelot Lake in 2006, followed closely by *Najas flexilis*. Sub-dominant were *Chara* spp. *Chara* spp dominated the aquatic plant community of Lower Camelot Lake in 2000. The next closest species was *Ceratophyllum demersum*, with half the dominance value of *Chara spp* in 2000. *Myriophyllum spicatum* and *Phalaris arundinacea*, the exotics found Lower Camelot Lake, were not present in high frequency or high density, but *Myriophyllum spicatum* had substantial dominance in both years.

Looking at the results from the 2000 survey and those from 2006 shows some changes in the aquatic plant community, not necessarily for the better. Although there were slightly more species found in 2006, the structure of the aquatic plant community has become more unbalanced, shifting to even more submergent vegetation, with fewer emergent, floating-leaf and free floating aquatic plants. Although species richness, the

Floristic Quality Index, the Average Coefficient of Conservatism, and the AMCI has stayed close in value, these values are still below or barely at average.

Further, when calculating the Coefficient of Similarity between the 2000 and 2006 surveys, they score as statistically dissimilar. Based on frequency of occurrence and relative frequency, the aquatic plant communities of the two years are only 65% similar. Similarity percentages of 75% or more are considered statistically similar; obviously, Lower Camelot Lake percentages are far from that. It is worth noting that the report on the 2000 aquatic plant surveys mentioned the absence of emergent plants in Lower Camelot Lake. The 2006 survey shows that emergent plants are even more scarce in Lower Camelot Lake than they were in 2000. *Vallisneria americana*, which is encouraged by harvesting, has increased in frequency and density two to three fold. *Najas flexilis*, a disturbance indicator, has more than doubled.

Of the 29 species found in Upper Camelot Lake, 27 were native and 2 were exotic invasives. In the native plant category, 9 were emergent, 1 was a floating-leaf plant, 1 was free-floating and 16 were submergent species. Two exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed) were found. Filamentous algae were found at 8.22% of the sample sites in 2006 and at 29.51% of the sites in 2000.

Chara spp was the most frequently-occurring "plant" in Upper Camelot Lake in 2006, as it was in 2000. No species but *Chara* spp reached a frequency of 50% or greater in the lake overall in either 2000 or 2006. When reviewing the occurrence frequency within vegetated areas in 2006, only *Chara* spp reached an occurrence frequency over 50%; next closest was *Najas flexilis* at 36.62% occurrence within vegetated beds. The same pattern was followed in 2000, with *Najas flexilis* occurring at 45.90% where present.

Chara spp was also the densest plant in 2006 in Upper Camelot Lake, with a mean density of 1.92 (on a scale of 1 to 4). In the lake overall, none of the aquatic vegetation had a mean density of over 2.0, meaning none occurred at more than average, in 2006.

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Chara* spp was the dominant aquatic "plant" species in Upper Camelot Lake in 2006, followed by *Najas flexilis*. *Chara* spp dominated the aquatic plant community of Upper Camelot Lake in 2000, with *Najas flexilis* coming in second. *Myriophyllum spicatum* and *Phalaris arundinacea*, the exotics found Upper

Camelot Lake, were not present in high frequency, high density or high dominance in either year, although *Myriophyllum spicatum* had a greater presence in 2000.

Species richness increased slightly between 2000 and 2006, with the biggest increase in richness found in Depth Zone 1 (0-1.5').

Overall, most species have not changed in frequency, but a few species have shifted their standing in the community; for example, *Ceratophyllum demersum* and *Potamogeton pectinatus* have increased, but *Elodea canadensis* and *Potamogeton amplifolius* have increased. It is worth noting that the report on the 2000 aquatic plant surveys mentioned the low level of emergent plants in Upper Camelot Lake. The 2006 survey shows that occurrence and cover of emergent plants are were still scarce in Upper Camelot Lake, scarcer than they were in 2000, but there were more species of emergent plants in 2006. Some valuable pondweeds and water smartweed have increased; *Elodea canadensis*, *Myriophyllum spicatum,* and some sensitive pondweeds have declined substantially. Water clarity may have improved, but disturbance level is still high.

An aquatic plant survey was conducted by WDNR staff in 2000 of Camelot Channel. This survey found that 90% of the sample sites in the channel were vegetated with aquatic plants, with the 0-1.5' depth supporting the highest mean number of species per site. The plant-like algae, *Chara* spp (muskgrass),was the most frequently-occurring aquatic "plant" species in the Camelot channel, followed by *Najas flexilis.* Only *Chara spp.* occurred at more than 50% frequency, although *Najas flexilis* was close at 48.39%. *Chara spp* also had the highest density and was the only species occurring at more than average density. Other plants found in the channel included *Carex lacustris, Eleocharis acicularis, Eleocharis palustris, Elodea canadensis, Potamogeton nodosus, Potamogeton pectinatus, Potamogeton pusillus, Potamogeton zosteriformis, Typha angustifolia* and *Zosterella dubia.* In addition, two invasives, *Myriophyllum spicatum* (Eurasian watermilfoil) and *Phalaris arundinacea* (Reed Canarygrass) were found in 2000, although neither of them occurred at high frequency, density or dominance.

Of the 28 species found in the Camelot Channel, 25 were native and 3 were exotic invasives. In the native plant category, 9 were emergent, 1 was a floating-leaf plant, and 15 were submergent species. Three exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) , *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton* crispus (Curly-Leaf Pondweed) were found. Filamentous algae were found at 25.58% of the sample sites in 2006 and at 33.33% of the sites in 2000.

Najas flexilis was the most frequently-occurring plant in Camelot Channel in 2006 (with 93.55% occurrence frequency), followed by *Myriophyllum spicatum* at 61.29 % occurrence frequency. In 2000, *Chara* spp. was the most-frequency occurring species, with *Myriophyllum spicatum* second with 48.39% occurrence frequency. No other species reached a frequency of 50% or greater in the lake overall in either 2000 or 2006.

Further, when calculating the coefficient of similarity between the 2000 and 2006 surveys, they score as statistically dissimilar. Based on frequency of occurrence, the aquatic plant communities of the two years are only 45% similar. Similarity percentages of 75% or more are considered statistically similar; obviously, the Camelot Channel percentages are far from that. Emergent vegetation (an important habitat component) has decreased by nearly one-half, and floating-leaf vegetation is very sparse. Disturbance indicator, *Chara*, has decreased substantially, but another disturbance indicator, *Najas flexilis*, has increased, as has *Myriophyllum spicatum* (Eurasian Watermilfoil).

The Camelot Lakes have four known invasive aquatic plant species: Curly-Leaf Pondweed (submergent); Eurasian Watermilfoil (submergent); Purple Loosestrife (emergent); and Reed Canarygrass (emergent). These lakes get a significant amount of transient boat traffic, as well as heavy use by local landowners. The Tri-Lakes Management District has a lake management plan that includes management of aquatic invasives. The lake has been using targeted harvesting for Eurasian Watermilfoil, emphasizing the harvesting of that plant in May and September, while harvesting the summer months for navigation, rather than control of Eurasian Watermilfoil. In 2007, some lake citizens were trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program. The lake also has the invasive animals, Zebra Mussels and Rusty Crayfish.

<u>Fish/Wildlife/Endangered Resources</u>

The most recent fishing inventory of the Camelot Lakes, in 2002, showed that bluegills, largemouth bass and yellow perch were abundant. Crappies, northern pike and walleyes were present, but scarce. In the past, bullheads, golden shiners, pumpkinseeds and white suckers have also been found in the lake, as have carp. There was a chemical kill of fish on the Tri-Lakes in 1967 to deal with carp. There is also a history of fish kills from the *Columnaria* bacteria (a native bacteria). WDNR stocking records indicate stocking of bluegills, largemouth bass, northern pike and walleye in the past.

Muskrats have been seen on these lakes. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lakeshores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

There are endangered resources known to be in the Camelot watersheds. The long-leaved aster (*Aster longifolius*) is the only special plant reported there, but there are three butterflies, a leafhopper and a bird also known to be there. The butterflies are the Gray Copper butterfly (*Lycaena dione*), the Karner Blue Butterfly (*Lycaedides melissa samuelis*), and the Regal Fritillary butterfly (*Speyenia idalia*). The Greater Prairie Chicken (*Tympanuchus cupido*) has booming grounds in the eastern part of the watersheds. A leafhopper (*Graphocephala* spp) has also been reported in these watersheds.

<u>Conclusion</u>

The Camelot Lakes are impoundments impacted substantially by their positions in the large surface and ground watersheds of the Tri-Lakes, as well as significant disturbances. It is approaching the threshold of passing from an aquatic plant-dominated system to a turbid algae-dominated system. The Tri-Lakes Management District will need to regularly review and update its lake management plan in order to address its management issues in a logical, cohesive manner.

<u>RECOMMENDATIONS</u>

Lake Management Plan

- When the Tri-Lakes Management District revises the lake management plan, it needs to make sure the plan includes at least the following aspects concerning the management of the lake: integrated aquatic species management; control/management of invasive species; wildlife and fishery management; nutrient budgeting; shoreland protection; water quality protection.
- The Lake Camelot Prope6ry Owners Association should participate in the revision process and implementation of the lake management plan.

Watershed Recommendations

- Since computer modeling results suggest that input of nutrients, especially phosphorus, are a factor that needs to be explored for the Camelot Lakes, it is recommended that both the surface and ground watersheds be inventoried, documenting any of the following: runoff from any livestock operations that may be entering the surface water; soil erosion sites; agricultural producers not complying with nutrient management plans and/or irrigation water management plans.

- If such sites are documented, a statement outlining the Camelot Property Owners Association and Tri-Lake Management District's encouragement to Adams County Land & Water Conservation Department and landowners to design and implement practices to address the sites.

Water Quality Recommendations

- All lake residents should practice best management on their lake properties, including keeping septic systems maintained in proper condition and pumped every three years, eliminating the use of lawn fertilizers, cleaning up pet wastes and not composting near the water.
- Reducing the amount of impervious surface around the lake and management of stormwater runoff will also help maintain water quality.
- Residents should become involved in the Citizen Lake Water Monitoring Program. This program includes water quality monitoring, invasive species monitoring, and Clean Boats, Clean Waters.
- Broad-scale restoration of native vegetation at the shore is needed to help improve water quality. Studies show that the frequency and density of the most sensitive plant species is less at disturbed shores than at those with native vegetation. These plants are indicators of water quality.
- Further investigation of the sources of the elevated chloride, nitrogen and sulfate needs to be made to identify such sources and develop a plan to reduce those elevated levels.

Aquatic Plant Recommendations

- All lake users should protect the aquatic plant community in these lakes by assisting in revising implementing an integrated aquatic plant management plan that uses multiple methods of control.
- The Tri-Lakes Management District should maintain exotic species signs at the boat landings and contact DNR if the signs are missing or damaged.
- The Tri-Lakes Management District should continue monitoring and control of Eurasian Watermilfoil and Curly-Leaf Pondweed, maintaining the most effective methods and modifying if necessary. The Camelot Property Owners Association should assist in these efforts. Residents may need to hand-pull scattered plants.
- Lake residents should get involved in the county-sponsored Citizen Aquatic Invasive Species Monitoring Program. This will allow not only noting changes in the Eurasian Watermilfoil pattern and Curly-Leaf Pondweed, but also for other invasives, including the zebra mussels already known to be present in Arrowhead Lake. Noting the presence and density of invasives early is the best way to take preventive action to keep them from becoming a bigger problem.

- Emergent vegetation, which is very sparse in both Camelot Lakes, should not be removed. In fact, removal of aquatic plants and shore plants should be kept to the maximum 30' wide viewing/access corridor and navigation purposes. Leave as much vegetation as possible to protect water quality and habitat.
- Natural shoreline should be restored and eroded areas repaired. Disturbed shoreline covers too much of the shore and mowed lawn alone covers nearly half of the shore.
  a) Unmowed native vegetation reduces shoreline erosion and run-off into the lake and filters the run-off that does enter the lake thus reducing nutrient inputs.
  b) Shoreline restoration could be a as simple as leaving a band of natural vegetation around the shore by discontinuing mowing.
  c) Restoration could be as ambitious as extensive plantings of attractive native wetland species in the water and native grasses, flowers, shrubs and trees on the near shore area.

LAKE CLASSIFICATION REPORT
FOR UPPER AND LOWER LAKES, ADAMS COUNTY

INTRODUCTION

In 2003, The Adams County Land & Water Conservation Department (Adams County LWCD) determined that a significant amount of natural resource data needed to be collected on the lakes with public access in order to provide it and the public with information necessary to manage the lakes in a manner that would preserve or improve water quality and keep it appropriate for public use. In some instances, there was significant historical data about a particular lake; in that instance, the study activities concentrated on combining and updating information. In other instances, there was no information on a lake, so study activities concentrating on gathering data about that lake. Further, it was discovered that information was scattered among various citizens, so often what information was actually available regarding a particular lake was unknown. To assist in updating some information and gathering baseline information, plus centralize the data collected, so the public may access it. The Adams County LWCD received a series of grants from the Wisconsin Department of Natural Resources (WDNR) from the Lake Classification Grant Program.

Objectives of the study were:

- collect physical data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- collect chemical and biological data on the named lakes to assist in assessing the health of Adams County lake ecosystems and in classifying the water quality of the lakes.
- develop a library of lake information that is centrally located and accessible to the public and to City, County, State and Federal agencies.
- make specific recommendations for actions and strategies for the protection, preservation and management of the lakes and their watersheds.
- create a baseline for future lake water quality monitoring.
- Provide technical information for the development of comprehensive lake management plans for each lake
- provide a basis for the water quality component of the Adams County Land and Water Resource Management Plan. Components of the plan will be incorporated into Adams County's "Smart Growth Plan".
- develop and implement educational programs and materials to inform and education lake area property owners and lake users in Adams County.

METHODS OF DATA COLLECTION

To collect the physical data, the following methods were used:

- delineation & mapping of ground & surface watersheds using topographic maps, ground truthing and computer modeling;
- identification of flow patterns for both the surface & ground watersheds using known flow maps and topographic maps;
- inventory & mapping of current land use with orthographic photos and collected county information;
- inventory & mapping of shoreline erosion and buffers using county parcel maps and visual observation;
- inventory & mapping for historical and cultural sites using information from the local historical society and the Wisconsin Historical Society;
- identification & mapping of critical habitat areas with WDNR and Adams County LWCD staff;
- identification & mapping of endangered or threatened natural resources (including natural communities, plant & animal species) using information from the Natural Heritage Inventory of Wisconsin;
- identification & mapping of wetland areas using WDNR and Natural Resource Conservation Service wetland maps;
- preparation of soil maps for each of the lake watersheds using soil survey data from the Natural Resource Conservation Service.

To collect water quality information, different methods were used:

- for three years, lakes were sampled during late winter, at spring and fall turnover, and several times during the summer for various parameters of water quality, including dissolved oxygen, relevant to fish survival and total phosphorus, related to aquatic plant and algae growth;
- random samples from wells in each lake watershed were taken in two years and tested for several factors;
- aquatic plant surveys were done on all 20 lakes and reports prepared, including identification of exotics, identifying existing aquatic plant community, evaluation of community measures, mapping of plant distribution, and recommendations;
- all lakes were evaluated for critical habitat areas, with reports and recommendations being made to the respective lakes and the WDNR;
- lake water quality modeling was done using data collected, as well as historical data where it was available.

WATER QUALITY COMPUTER MODELING

Wisconsin developed a computer modeling program called WiLMS (Wisconsin Lake Modeling Suite) to assist in determining the amount of phosphorus being loaded annually into a lake, as well as the probable source of that phosphorus. This suite has many models, including Lake Total Phosphorus Prediction, Lake Eutrophic Analysis Procedure, Expanded Trophic Response, Summary Trophic Response, Internal Load Estimator, Prediction & Uncertainty Analysis, and Water & Nutrient Outflow. The models that various types of data inputs: known water chemistry; surface area of lake; mean depth of lake; volume of lake; land use types & acreage. This information is then used in the various models to determine the hydrologic budget, estimated residence time, flushing rate, and other parameters.

Using the data collected over the course of the studies, various models were run under the WiLMS Suite. These water quality models are computer-based mathematical models that simulate lake water quality and watershed runoff conditions. They are meant to be a tool to assist in predicting changes in water quality when watershed management activities are simulated. For example, a model might estimate how much water quality improvement would occur if watershed sources of phosphorus inputs were reduced. However, it should be understood that these models predict only a relative response, not an exact response. Modeling results will be incorporated into topic discussions as appropriate.

DISSEMINATION OF PROJECT DELIVERABLES

The results of this study will be distributed various agencies, organizations and the public as previously described. Based on the classification information, the Adams County Land and Water Conservation Department will identify assistance requests and determine the appropriate future activities, based on the classification determinations. To provide the requested assistance, Adams County Land and Water Conservation Department will incorporate the lake management plans goals, priorities and action items into its Annual Plan of Operations. Goals, priorities and action items may include educational programs, formation of lake districts, further development of lake management plans and implementation of lake management plans.

ADAMS COUNTY INFORMATION

Adams County lies in south central Wisconsin, shaped roughly like the outline of Illinois. Adams County is a small rural county with a full-time population of about 20,000. Between 1980 and 2000, Adams County's population grew by more than 20%, with most of the population increase being located upon the lakes and streams. The population increase has resulted in a greater need for facilitation, technical assistance and education, including information on the lakes and streams.

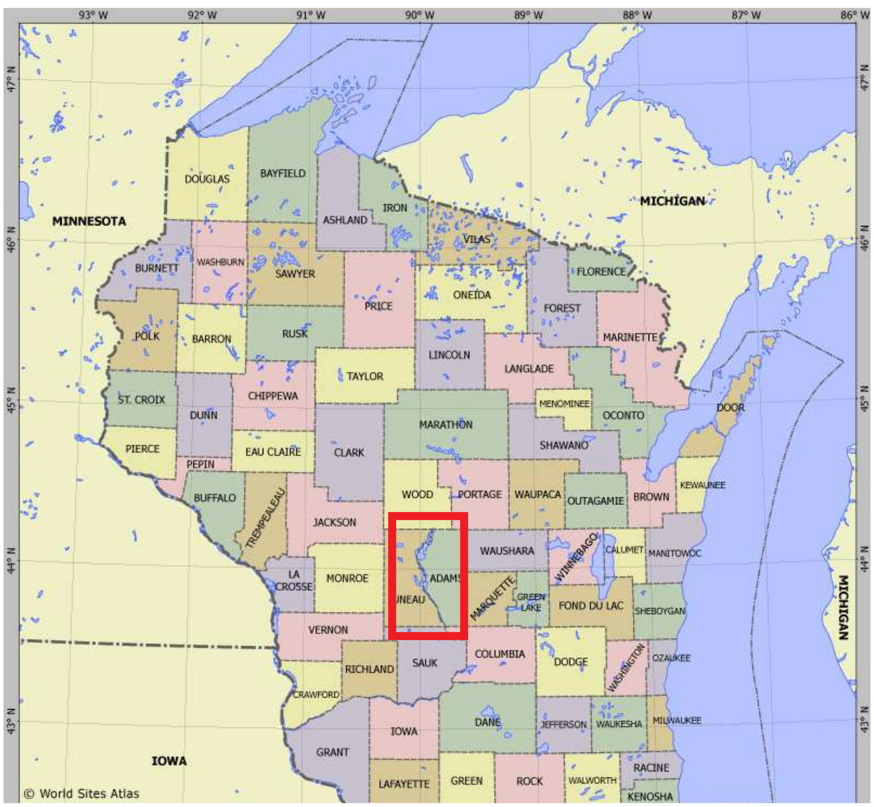


Figure 1: Adams County Location in Wisconsin

CAMELOT LAKES BACKGROUND INFORMATION

The Camelot Lakes are located in the Town of Rome, Adams County, WI (T20N, R6E), in the south central part of Wisconsin. They are part of a series of lakes commonly called “Tri-Lakes”. Lower Camelot Lake is the first lake in the series, where Fourteen Mile Creek enters. Lower Camelot Lake is 260 surface acres, with a maximum depth is 24’ and an average depth of 8’. Spring Branch Creek enters Upper Camelot Lake. Upper Camelot Lake has 191 surface acres, with a maximum depth of about 25’ and an average depth of 8’. A channel connects Lower Camelot Lake to Upper Camelot Lake. There is a public boat ramp located on southwest side of Lower Camelot Lake owned by The Adams County Parks Department. The dams that impound these streams & form the lakes are owned and maintained by Adams County. The lake shores on both lakes are heavily developed.

.

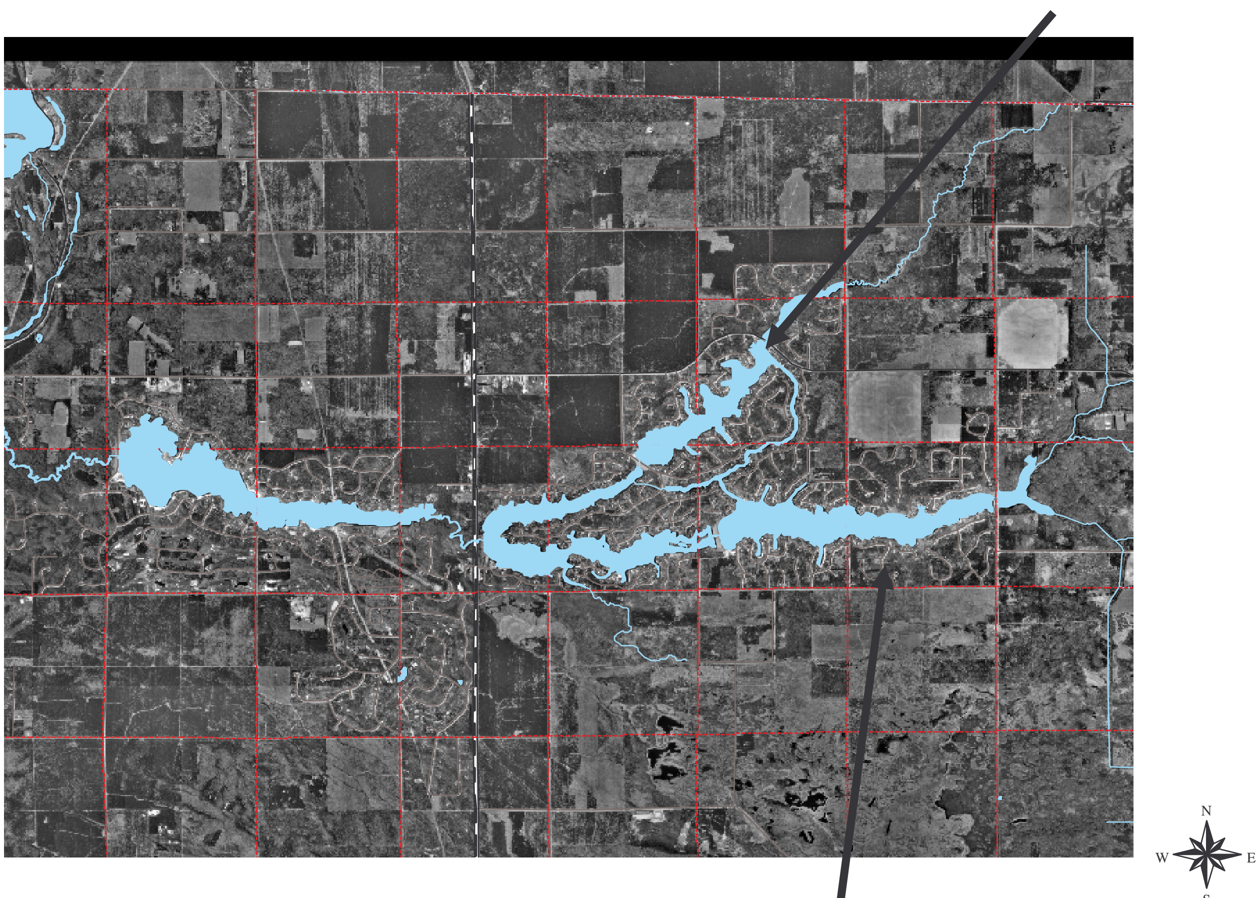


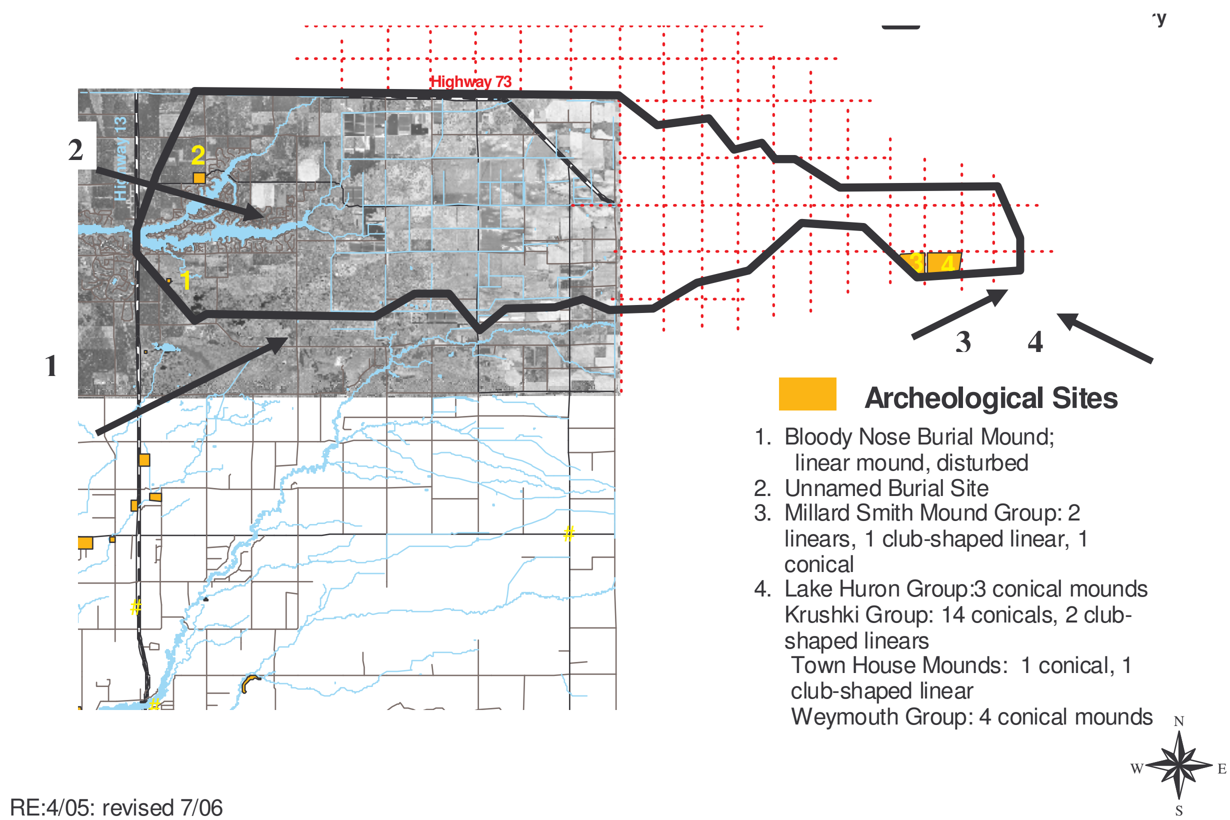
Figure 2: Camelot Lakes locations

RE:2/07

The Central Sand Plains, which contain the two Camelot lakes, lie in the Driftless Area of Wisconsin. The area is characterized by varying elevations, with numerous, usually flat-topped ridges & hills sometimes called "mounds." Deposits made by streams from the melting ice sheet cover large areas and usually consist of sand, clay and gravel.

Archeological Sites

Figure 3: Camelot Lakes Archeological Sites



There are many Native American archeological sites in Adams County, with several being located right around in the Tri-Lakes watersheds. These mounds can be conical, linear or effigy (animal shapes) shapes. In order to preserve Native American heritage, federal and state laws on Native American burials require permission of the federal government and input from the local tribes before further disturbance.

Bedrock and Historical Vegetation

Bedrock around the two Camelot Lakes is mostly sandstone, both weak and resistant, formed in the Cambrian Period of Geology (542 to 488 millions years ago). Bedrock may be 200 or more feet below the sand/clay/gravel deposits left by melting ice cover. Original upland vegetation of the area included extensive wetlands of many types (including open bogs, shrub swamps & sedge meadows), as well as prairies, oak forests, savannahs and barrens. Mesic white pine & hemlock forests were found in the northwest portion of the region. Most of the historic wetlands were drained in the 1900s and used for cropping. The current forested areas are mostly oak-dominated, followed by aspen and pines. There are also small portions of maple-basswood forest and lowland hardwoods.

Soils in the Camelot Lakes Watershed

The primary soil type in the both the ground and surface watersheds is sand. However, directly around the two Camelot Lakes, the soil is mostly sand.

Sandy soil tends to be excessively drained, no matter what the slope. Water, air and nutrients move through sandy soils at a rapid rate, so that little runoff occurs unless the soil becomes saturated. Although water erosion can be a problem, wind erosion may be more of a hazard with sandy soils, especially since these soils dry out so quickly. There are also draught hazards with sandy soils. Getting vegetation started in sandy soils is often difficult due to the low available water capacity, as well as low natural fertility and organic material. Onsite waste disposal in sandy soils is also a problem because of slope and seepage; mound systems are usually required.

Loamy sands tend to be well-drained, with water, air and nutrients moving through them at a rapid rate. Runoff, when it occurs, tends to be slow. Loamy sands have little water-holding capacity and low natural fertility, although they usually have more organic matter present than do sandy soils. Both wind and water erosion are potential hazards with loamy sands, as is drought. There are difficulties with waste disposal and vegetation establishment because of slope and seepage.

The soil and soil slopes around lakes and streams are very important to water quality. They affect amount of infiltration of surface precipitation into the ground and the amount of contaminants that may reach the groundwater, as well as the amount of surface stormwater runoff. In addition, these two factors affect the amount and content of pollutants and particles (including soil) that may wash into a water body, affecting its water quality, its aquatic plant community and its fishery. Further, soil types and soil slopes help determine the appropriate private sewage system and other engineering practices for a particular site, since they affect absorption, filtration and infiltration of contamination from engineering practices.

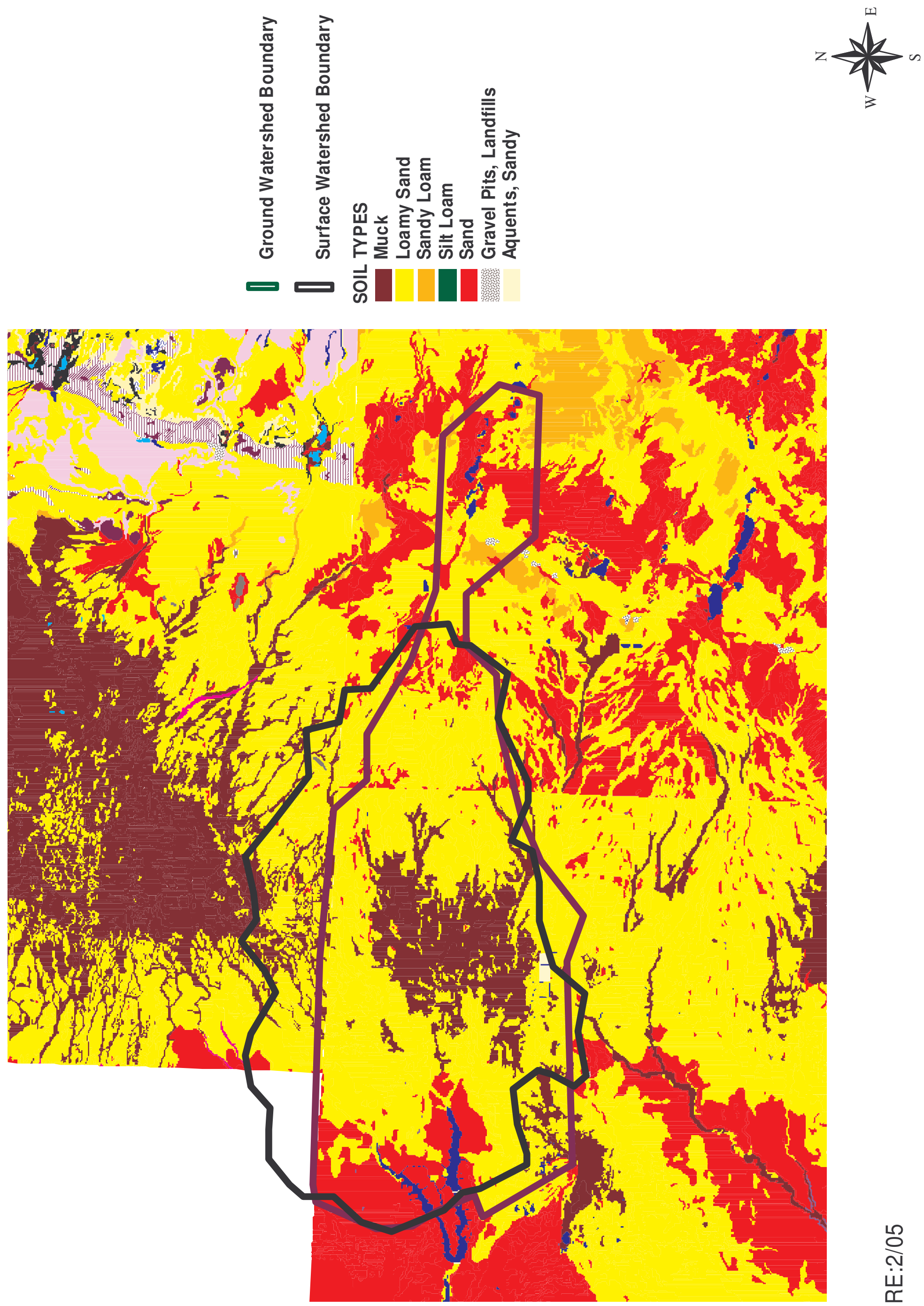


Figure 4: Camelot Lakes Soils

PRIOR STUDIES OF THE TRI-LAKES AREA

The Tri-Lakes Area, including the two Camelot Lakes, has been the subject of several different studies. In 1978, a "water management study" report, Fourteenmile Creek Watershed, was published by the University of Wisconsin-Madison, This summarized the results of a study done during the summer of 1978. The report noted that the first lake constructed in the system was Sherwood Lake, on which construction started in 1967. The last lake constructed was Arrowhead Lake. The report noted that the bulk of Arrowhead Lake's water came from the Sherwood Dam. Lower Lake Camelot was estimated to contribute 17% of the volume of Lake Sherwood's water. The Camelot Lakes were fed by 14-Mile Creek, the Leola Ditch System and Spring Creek. Very little of the water in the lakes was supplied by precipitation and groundwater.

By 1978, all of the Tri-Lakes had been constructed. The upper watershed was used mostly for agriculture and commercial forest. 70% of the agricultural fields were irrigated. Because of the concerns expressed by the landowners in the lower watershed (around the lakes), the report concentrated on studying that area.

A survey of lakeshore owners indicated that water weeds were seen as the most severe problem, followed by erosion, algal blooms and oil slicks from boat motors. There were also complaints about water "muddiness." Over one-half of the respondents thought that contributors to these problems included leaking septic systems, oil from boat motors, silt & sand from shoreline erosion, construction erosion and fertilizers from lawns and fields. Researchers saw lakes Camelot, especially Lower Camelot Lake, and Sherwood as more vulnerable to eutrophy because of their shallowness, relative clarity and abundant nutrients to encourage dense aquatic plant and algal growth. Arrowhead Lake was considered the least vulnerable to eutrophy. They indicated that the main causes of erosion were waves stirred up by winds or boat wakes. Further study revealed that wind was responsible for three times as many waves as boat wakes, but that boat wakes created many more large waves.

This report noted that Lower Lake Camelot tended to have oxygen-depleted waters in the deeper areas of the lake. Such oxygen depletion can result in the release of phosphorus from bottom sediments into the water column, making it more available for aquatic plant and algal growth. Lower Lake Camelot also had a higher flushing rate than did Upper Lake Camelot. There is a channel between the two Camelot Lakes that bring water from Lower Lake Camelot to Upper Lake Camelot.

Recommendations from this report included: (1) installation of shoreline protection practices to reduce erosion; (2) lakeside vegetation planting to reduce soil loss and help control erosion; (3) amendment of the Town of Rome boating ordinance to reduce the incidence of high energy, boat-generated waves by specifying speeds without certain distances from shores; (4) better enforcement of the current town boating ordinance to control boat speeds and water skiing issues; (5) continued stocking of game fish like pike & walleye, as well as fish habitat improvement within the lakes; (6) establishing a lake management district that included all the lakes.

In 1993, another report called Tri-Lakes, Adams County, Wisconsin: Lakes and Watershed Characterization was published. This study was funded by the WDNR and the Tri-Lakes Management District and performed by Blue Water Science of St Paul, Minnesota. Parameters researched during this study include collection of flow & total phosphorus data for the creek and ditches feeding into the Tri-Lakes; collecting lake water chemistry sample for one summer (1991); and estimating phosphorus load from various land uses and contribution sources. Runoff was estimated at 6.3 inches per year. Secchi disk readings for Lower Lake Camelot ranged from 3 feet (August 1989) to 8 feet (June/July 1990). Hypoxia in the water column increased as the summer went on. The highest total phosphorus reading was 42 micrograms/liter in August 1989; the lowest was 20 micrograms/liter in August 1990. Chlorophyll-a levels ranged from 15 micrograms/liter to 22 micrograms/liter in the same time period. Although total phosphorus levels were fairly low for an impoundment, nitrate tended to be high in the lake.

Secchi disk readings for Upper Lake Camelot ranged from 3 feet (August 1989) to 12feet (June 1991). Hypoxia in the water column increased as the summer went on. Highest total phosphorus reading was 32 micrograms/liter in August 1989, with the lowest in August 1991 of 13 micrograms/liter. Chlorophyll-a levels ranged from 6 micrograms/liter to 11 micrograms/liter in the same time period. Although total phosphorus levels were fairly low for an impoundment, nitrate tended to be high in the lake.

The report estimated nutrient loading for Upper Camelot Lake at 228.4 pounds/acre/year. Nutrient loading for Lower Lake Camelot was estimated at 1094.7 pounds/acre/year. In the instance of Upper Camelot Lake, nearly 39% of the loading was estimated to come from septic tanks. Only 5.4% of the loading on Lower Camelot Lake was estimated to come from septic tanks.

The report made several recommendations; (1) to continue efforts to reduce wind erosion through practices such as tree planting, snow fence planting, residue management, etc.; (2) to continue monitoring incoming stream water and lake water, examining at least total phosphorus, nitrate-nitrite, total Kjeldahl nitrogen and total suspended solids; (3) conduct bioassays on the 14-Mile Creek bedloads, since it was estimated that their phosphorus level was considerably higher than that of the creek surface water; (4) to continue a lake and watershed information & education program using activities such as newsletters, lake fair picnics, underwater video, demonstration projects, appointment of lake captains responsible for information distribution on their lakes; (5) to conduct plan surveys & monitor the amount of plant removal by monthly analyzing plants mechanically harvested for total phosphorus on each lake; (6) to install demonstration projects for aquatic plant control nearshore by methods other than herbicides; (7) to landscape lake shores for wildlife, shore protection & erosion control; and (8) to perform an on-site waste system evaluation and conductivity study, taking samples that were analyzed for fecal coliform & fecal streptococcus bacteria.

In April, 1999, Mid-State Associates Professional Services published the results of a septic study it had done of several septic sites around the Camelot Lakes. Houses tended to be within 100 feet of the waterfront, with lakeshores narrow and houses close together. MSA found that the septic sites were within code. However, testing of the soil underneath the absorption fields showed significant increases in phosphorus compared to the phosphorus levels of soil not under septic fields. Further, elevated phosphorus concentrations were found at depths greater than 3 feet below the base of the drainfields, with older sites have higher phosphorus concentrations. The report noted that the sandy soils in the drainfields had a low capacity to retain phosphorus. According to this report, previous studies in 1979 and 1993 had overestimated the sandy soils' ability to retain phosphorus. The report also indicated that septic systems phosphorus input was likely to grow as development increased and the sandy soils reached their phosphorus saturation point. It estimated that at the time of the study, septic systems could be contributing as much as 12% of the phosphorus ending up in the Camelot Lakes. The report recommended four alternatives to be considered in place on continuing to use many individual private septic systems: (1) centrally collect wastewater and discharge it outside the Tri-Lakes watersheds; or (2) centrally collect wastewater and pump it into an existing municipal sewage system; or (3) use cluster type wastewater collection with nutrient removal and discharge of treated water; or (4) use nutrient removal techniques in the individual on-site waste systems.

The results of a study of the algae in the Camelot Lakes were outlined in a report titled <u>Phytoplankton Community Composition and Distribution in the Tri-Lakes Area</u>, written by Dr. Robert Bell, UWSP-Biology Department, published in 2000. He found that Upper Camelot Lake had 55 genera of algae, with Lower Camelot Lake having 53 genera. The taxa found were generally unremarkable and were seen as typical of a mesotrophic of slightly eutrophic lake. Dr. Bell felt that at that time, heavy aquatic plant growth was more of a problem than seasonal algal blooms, but that he expected the levels of cyanobacteria (blue-green algae) to increase as the algal community shifted from one roughly equally spot of cyanobacteria, ochrophytes (pigmented algae) and green algae to one of predominately cyanobacteria. He made the following recommendations: (1) reduce the upstream input of pesticides & growth-promoting nutrients by using sediment traps or lagoons; (2) remove in-lake nutrients via sediment and/or plant biomass removal; (3) reduce residential nutrient input by improved septic/ sanitation systems and shoreline vegetation filter strips.

In December 2001, a report titled Assessment of Shallow Groundwater Flow & Chemistry & Interstital Water Sediment, Aquatic Macrophyte and Chemistry for the Tri-Lakes, Adams County, WI, was published. It was written by B. Shaw, C. Sparacio, J. Stelzer and N. Turyk of UWSP. Objectives of this study were: (1) to compare groundwater flow patterns during full & drawn-down conditions; (2) to examine water quality after heavy summer use; (3) to monitor groundwater entering back bays in Camelot & Arrowhead Lakes for local impacts such as septics and/or lawns; (4) to determine nutrients & biomass of aquatic macrophytes as they relate to nutrients in interstitial water & lake sediments; and (5) to determine quantity of phosphorus and nitrogen held by plant tissues to estimate harvest removal. This study found that Upper Camelot Lake had a complex groundwater flow pattern. The Walden area of the lake was up-welling at the east end, no-welling in the middle, and down-welling on the north side. On the lake itself, the eastern half of Upper Camelot Lake tended to have no-welling sites, while down-welling dominated the downstream area. However, when the lake was drawndown, as it was for many years, 2/3 of the sites on the eastern and northern ends turned to up-welling sites (i.e., drawing groundwater into the lake). The lower 1/3 of the lake stayed as down-welling. For Lower Camelot Lake, this study found that the eastern 2/3 of Lower Camelot Lake were mostly up-welling sites, with sporadic no-welling sites. During a drawdown, all but 4 of the sites were up-welling. No sites on Lower Camelot Lake were down-welling at any time.

The report noted that 3 of the 14 upwelling sites on Upper Camelot showed characteristics of septic contamination (elevated chloride & nitrogen levels. Half of the sites showed negative land use impacts. On Lower Camelot Lake, 17 of the 28 upwelling sites showed septic contamination. 5 of the 28 sites showed negative land use impacts. Such an increase in upwelling sites increased the potential for input of nutrients from local sources.

The study concluded that the fall drawdown & spring refill of Sherwood Lake and the Camelot Lakes resulted in nutrients being released from anaerobic sediments and negatively impacted lake water quality. The high reactive phosphorus and ammonium levels suggested that nutrient transport to the lake was significant, especially from the fall drawdown, which increased groundwater discharge to the lake. The report stated that there was nutrient availability from several sources, including (1) the anaerobic release of ammonium and phosphorus from high organic matter sediments; (2) the nutrient flux from groundwater inflow; and (3) the cycling of nutrients from lake to sediment to groundwater and back again.

A survey was done of Tri-Lakes property owners during 2001. Although 72% of the respondents felt that the lakes' water quality was "good" or "fair", 74% felt the water quality had declined since they started coming to the lake. The top three causes attributed by respondents were input from cranberry growers, fertilizer use and heavy recreational use. The presence of algal scum and reduced water clarity were cited as the top two water quality problems, with aquatic plant growth scoring near the bottom. Nearly 66% of the respondents fertilized their lawn, with only 25% using non-phosphorus fertilizer. 74% mowed over 25% if their lawn at their lakefront. 83.8% if the houses had 2 or 3 bedrooms. Main activities on the lake included swimming, boating and fishing. The three most common boat types were pontoon, fishing and skiing, with 56.7% of the respondents having a boat motor 50 horsepower or larger.

A report titled Limnological Investigations of Camelot, Sherwood and Arrowhead Lakes, WI, was written by W.F. James, J. Barko & H. Eaken of the U.S. Army Corps of Engineers in 2002. Field work for this report included evaluating total sediment, total nitrogen and total phosphorus loads in the lakes. This was done by sediment collecting & testing, as well as water quality monitoring and computer modeling. The report noted that total phosphorus and chlorophyll-a levels increased as one went west in the lake chain, with the Camelot Lakes having the lowest levels and Arrowhead Lake having the highest level, with Arrowhead Lake between the two. Secchi disk readings were lowest in August and September. There appeared to be little correspondence between elevated phosphorus loading and algal blooms. Camelot Lakes had the lowest algal bloom rates, while Arrowhead Lake had the highest. All of the Tri-Lakes were considered susceptible to declining water quality conditions with the expected increase of phosphorus loading.

CURRENT LAND USE

Both the ground and surface watersheds for the Camelot Lakes are large. The two most common land uses in both the ground and surface watersheds are agriculture and woodlands. (See Figures 5 through 7).

Figure 5: Camelot Lakes Watersheds Land Use in Acres and Percent of Total in 2004

	Surface		Ground		Total	
2 Camelot Lakes	Acres	% Total	Acres	% Total	Acres	% Total
Agriculture—Non Irrigated	**3250.09**	**27.16%**	**5348.05**	13.78%	**8598.14**	16.93%
Agriculture—Irrigated	**4016.26**	**33.56%**	**10,696.09**	27.56%	**14712.35**	28.97%
Government	**0**	**0.00%**	**0**	0.00%	**0**	0.00%
Grassland/Pasture	**95.04**	**0.79%**	**3888.78**	10.02%	**3983.82**	7.85%
Recreational	**0**	**0.00%**	**0**	0.00%	**0**	0.00%
Residential	**1009.05**	**8.43%**	**1618.39**	4.17%	**2627.44**	5.17%
Water	**545**	**4.55%**	**58.9**	0.15%	**603.9**	1.19%
Woodland	**3052.97**	**25.51%**	**17,200**	44.32%	**20252.97**	39.89%
total	**11,968.41**	**100.00%**	**38,810.21**	100.00%	**50778.62**	100.00%
	Surface		**Ground**		**Total**	

Prior information on the watersheds shows how land use has changed over the years. After a substantial increase in agricultural land use between 1978 and 1986, agricultural changes appear to have leveled off and are no longer increasing in acreage. Residential use in the watersheds has decreased overall, although residential use directly around the Tri-Lakes has increased. Woodlands have increased slightly.

Studies have shown that land use around a lake has a great impact on the water quality of that lake, especially in the amount and content of surface runoff. (James, T., 1992, I-10; Kibler, D.F., ed. 1982. 271) For example, while natural woodland may (on the average) absorb 3.5" out of a 4" rainfall, leaving only .5" as runoff, a residential area with quarter-acre lots may absorb only 2.3" of the 4", leaving 1.7" to run off the land into the lake—the same amount as may be expected to run off from a corn or soybean field. 1.7" of runoff translates into 46,200 gallons per acre ending up in the lake! Percentage of impervious surface, the soil type, vegetation present and slope of the site can all affect runoff volume. (Frankenberger, J, ID-230). The changes in the watershed land use are therefore likely to significantly increase the runoff in volume and content unless protection steps are taken.

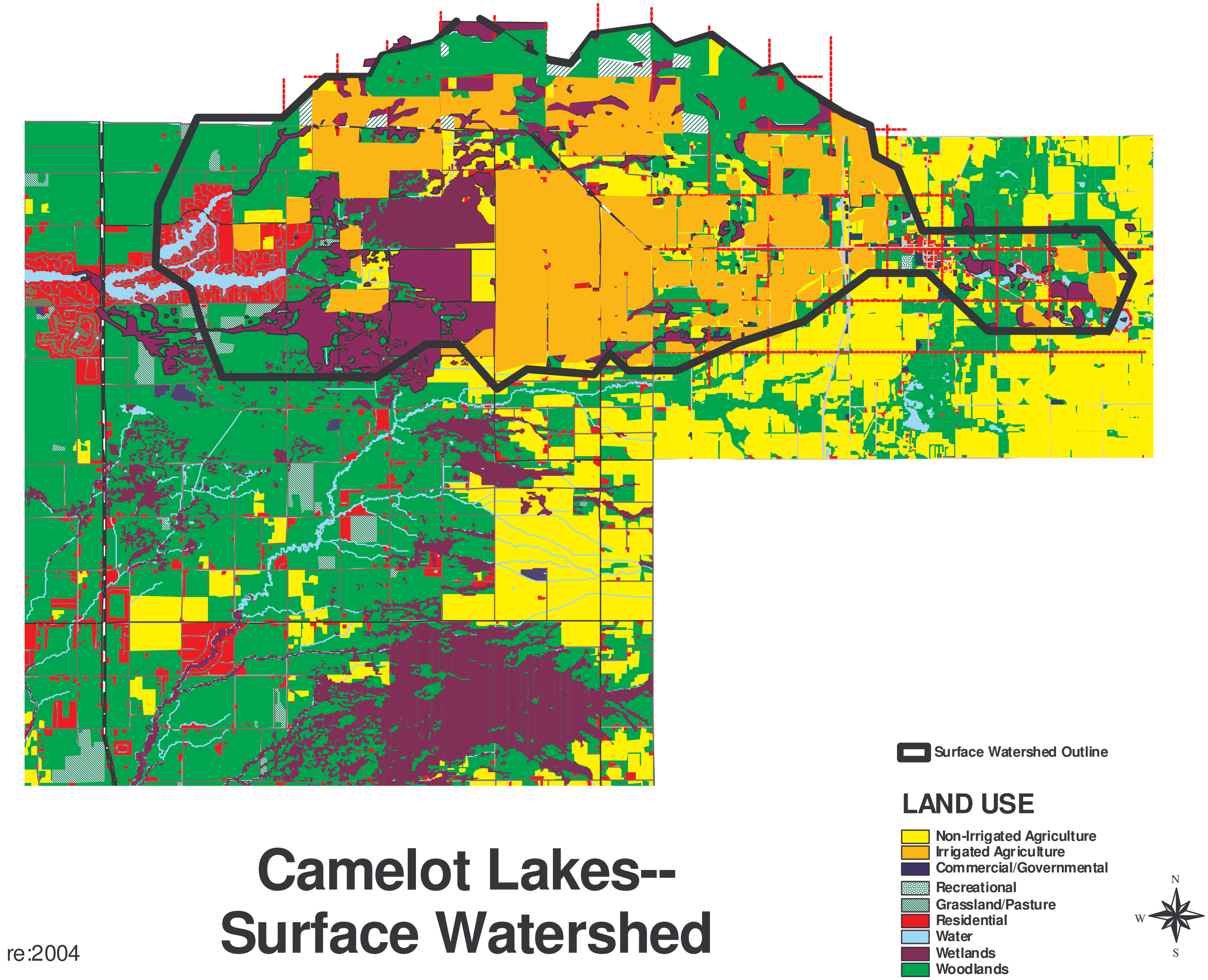


Figure 6a: Land use in Camelot Lakes Surface Watershed

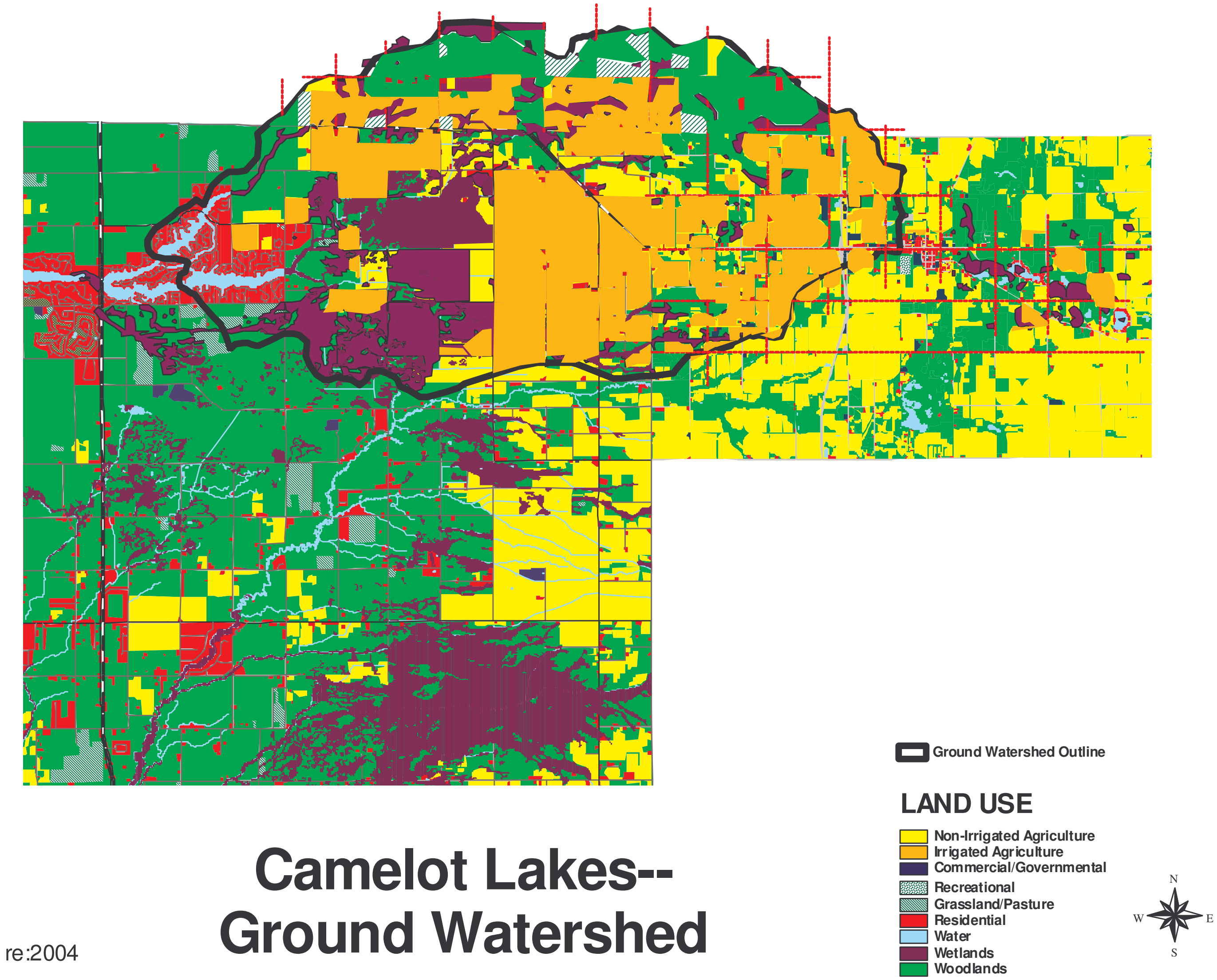
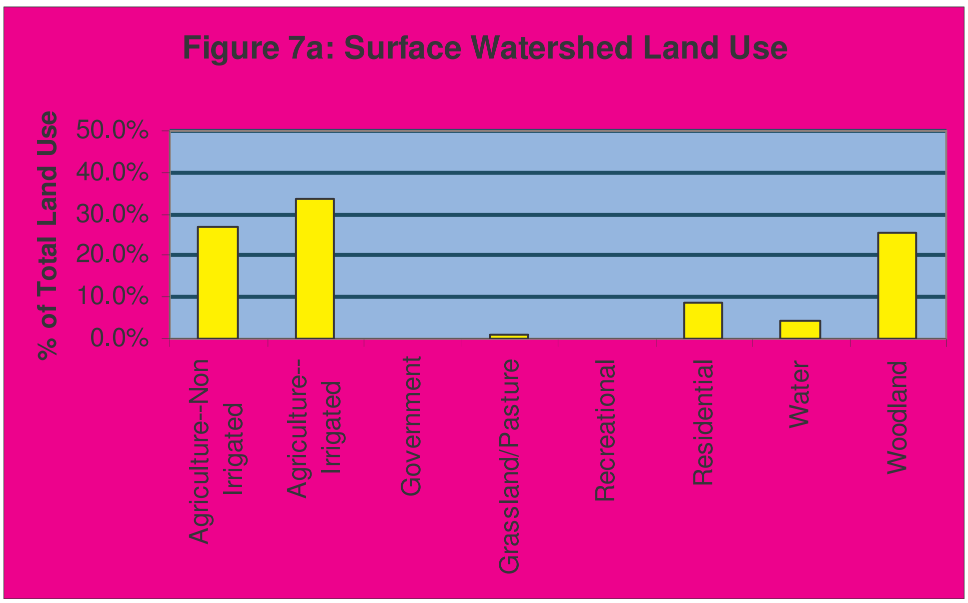
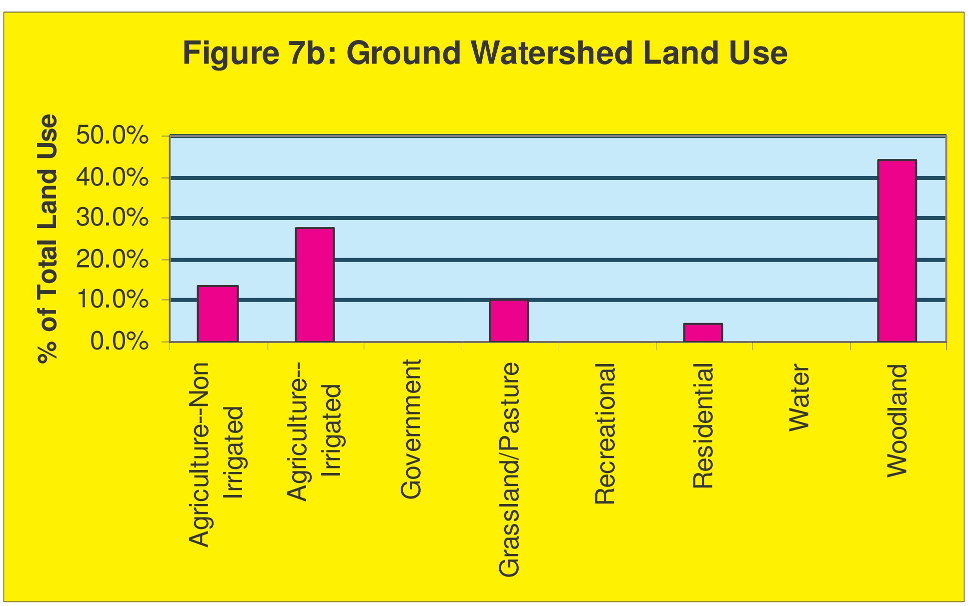


Figure 6b: Land Use in Camelot Lakes Ground Watershed

When water runs over a surface, it picks up whatever loose pollutants—sediment, chemicals, metals, exhaust gas, etc—are present on that surface and takes those items with it into the lake. Increased development around a lake tends to increase the amount of pollutants being carried into the lake, thus negatively affecting water quality. Residential development areas with lots of one-quarter acre or less may deliver as much as 2.5 pounds of phosphorus per year to the lake for each acre of development.





There are two specific kinds of land use—wetlands and shorelands—that are so important to water quality that they will be separately discussed.

WETLANDS

Many of the wetlands in the Camelot Lakes area are located in the Walden area and east of Lower Camelot Lake. In the past, wetlands were seen as "wasted land" that only encouraged disease-transmitting insects. Many wetlands were drained and filled in for cropping, pasturing, or even residential development. In the last few decades, however, the importance of wetlands has become evident, even as wetlands continue to decline in acreage.

Wetlands play an important role in maintaining water quality by trapping many pollutants in runoff and flood waters, thus often helping keep clean the water they connect to. They serve as buffers to catch and control what would otherwise be uncontrolled water and pollutants. Wetlands also play an essential role in the aquatic food chain (thus affecting fishery and water recreation), as well as serving as spaces for wildlife habitat, wildlife reproduction and nesting, and wildlife food.

The large areas of wetlands east if the Camelot Lakes serve as filters and traps that help reduce nutrient loading from the upper watersheds into the lakes. It is essential to preserve these wetlands for the health of all the Tri-Lakes.

Figure 8: Example of lake end wetland (not at Tri-Lakes)

SHORELANDS

The Camelot Lakes have a total shoreline of 18 miles (95,040 feet). The bulk of the lakeshores are in residential use, with several beach clubs also located on the lakes. Some of the areas near the shores are steeply sloped, some are quite flat. Shores tend to be soft sand and subject to easy erosion.

Only about 25% of Upper Camelot Lake's shore has native vegetation at the water line; 63.5% of the shore is covered with traditional cultivated lawn, hard structure (piers, seawalls, etc.) and rock riprap. Lower Camelot Lake's shore has even less native cover (23%) and has 60% of the "developed" shore of lawn/hard structure/rock riprap. The lake shores also have from 11% to 15% sand or active erosion. The Camelot Channel has only 11% native vegetation at the shore, with 75.5% of the shore being "developed."

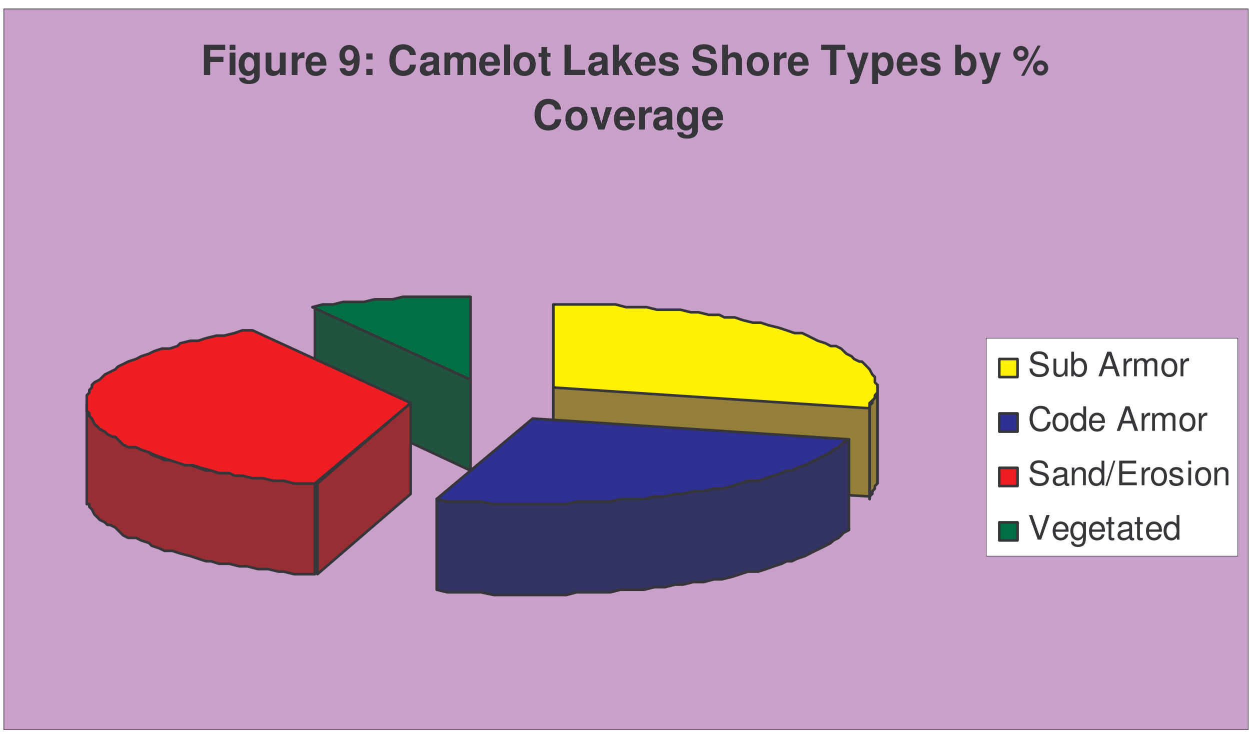


Figure 10a: Shoreland Map of Lower Camelot Lake (2004)

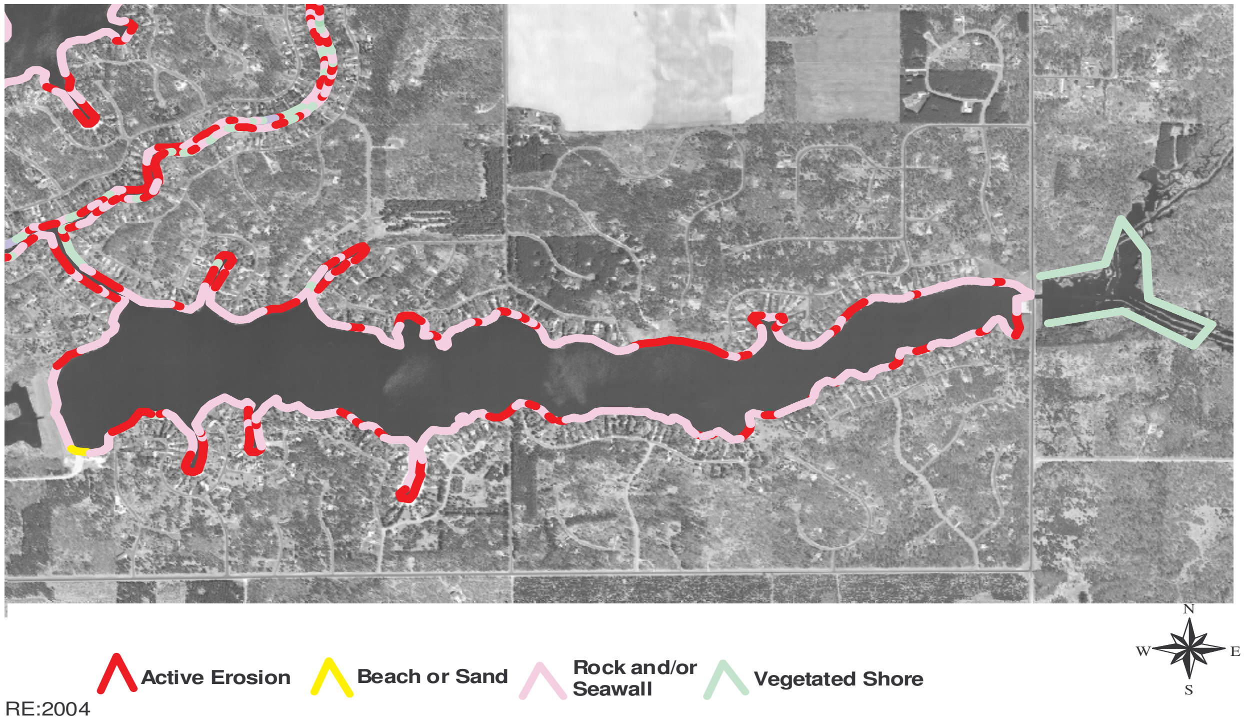
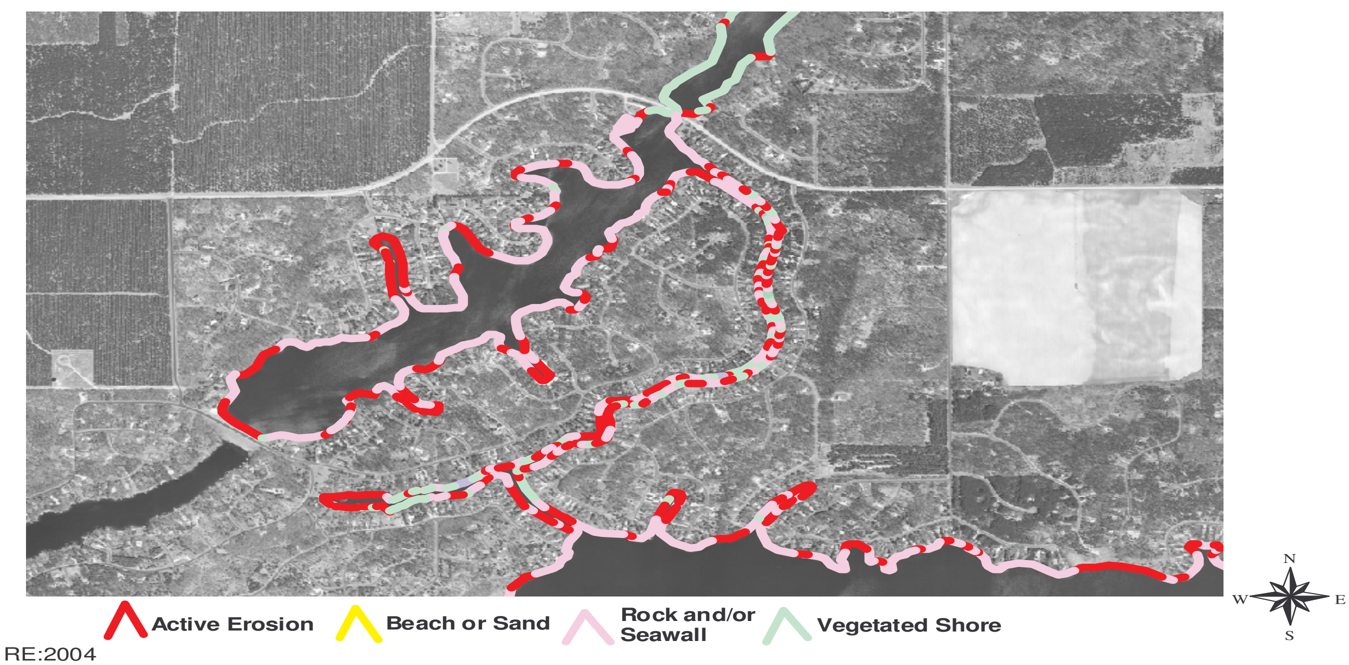


Figure 10b: Shore Map of Upper Camelot Lake (2004)



The Adams County Shoreline Ordinance defines 1000' landward from the ordinary high water mark as "shoreland". Under the ordinance, the first 35 feet landward from the water is a "buffer." Shoreland buffers are an important part of lake protection and restoration. These buffers are simply a wide border of native plants, grasses, shrubs and trees that filter and trap soil & similar sediments, fertilizer, grass clippings, stormwater runoff and other potential pollutants, keeping them out of the lake. A 1990 study of Wisconsin shorelines revealed that a buffer of native vegetation traps 5 to 18 times more volume of potential pollutants than does a developed, traditional lawn or hard-armored shore.

A 2004 shore survey showed that very few of the shores on these lakes and channel had an "adequate buffer." An "adequate buffer" is a native vegetation strip at least 35 feet landward from the shore. Most of the "inadequate" buffer areas were those with significant hard structures (piers, patios, etc.), mowed lawns and/or insufficient native vegetation or at the shoreline to cover 35 feet landward from the water line.

Vegetated shoreland buffers help stabilize shoreline banks, thus reducing bank erosion. The plant roots give structure to the bank and also increase water infiltration and decrease runoff. A vegetated shore is especially important when shores are steep and soft, as are many of shores on both Camelot Lakes. Figure 11 maps the adequate and inadequate buffers on the two Camelot Lakes.

Figure 11a: Lower Camelot Lake Buffer Map (2004)

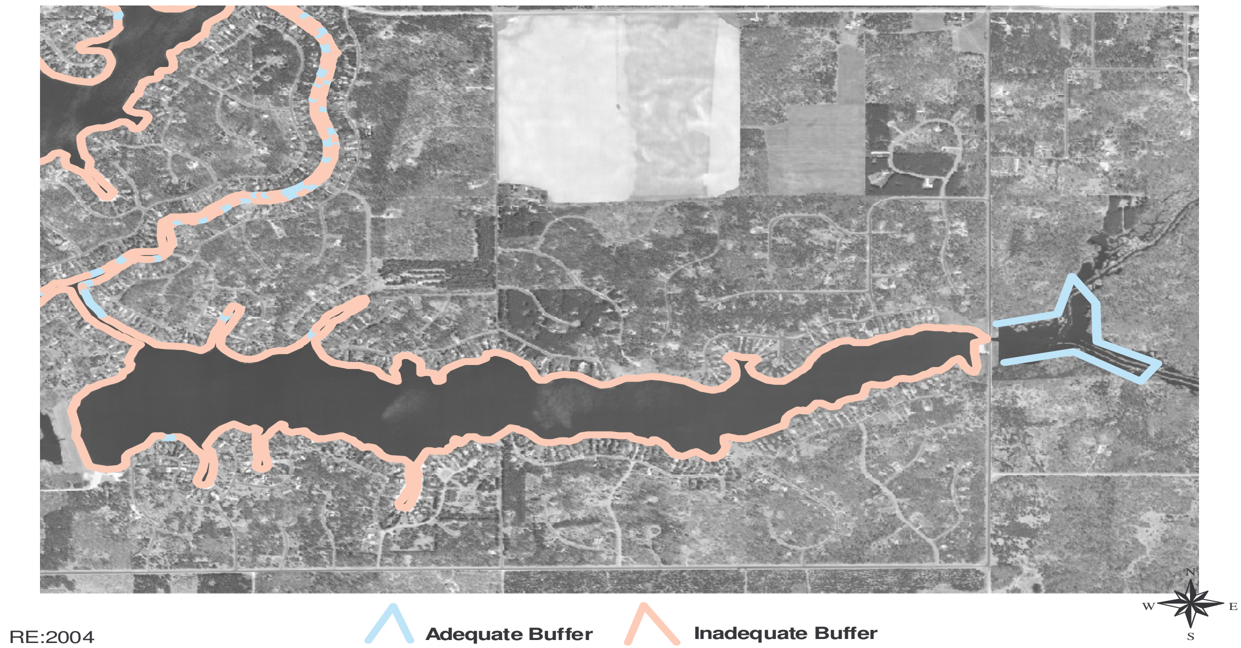
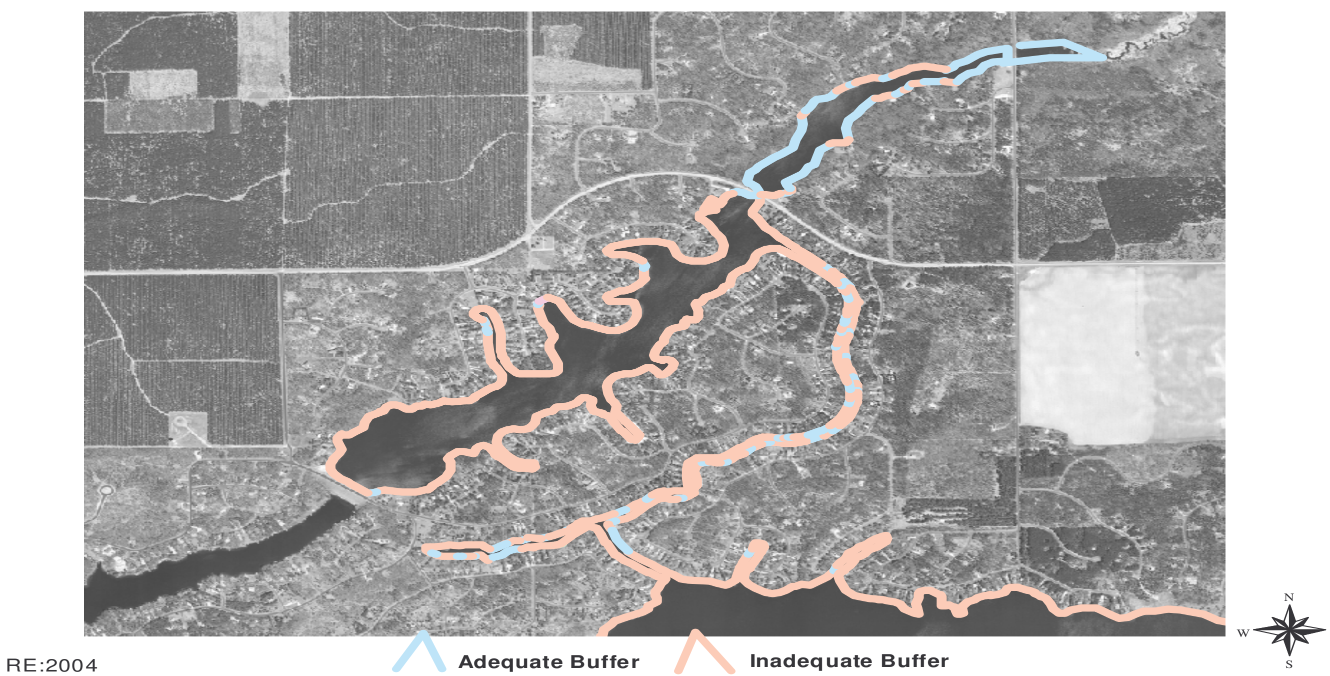


Figure 11b: Buffers on Upper Camelot Lake & Camelot Channel (2004)



Lakeside buffers also serve as important habitat. Lake edges usually contain aquatic and wetland plants, grading into drier groundcover, then shrubs and trees as one moves inland towards drier land. Buffers provide habitat for many species of water-dependent wildlife, including furbearers, reptiles, birds and insects. Many wildlife species, including birds, small mammals, fish & turtles breed, nest, forage and/or perch in shore buffer areas. Further, 80% of the endangered and threatened species listed spend part of their life in this near-lake buffer area. (Wagner et al, 2006)

When the natural shoreline is replaced by traditional mowed turf-grass lawns, rock, wooden walls or similar installments, bird and animal life, land-based insects, and aquatic insects that hatch or winter on natural shore are negatively impacted. For example, on many Adams County lakes, the non-native aquatic plant, Eurasian Watermilfoil has invaded. There is a weevil native to Wisconsin that weakens Eurasian Watermilfoil by burrowing into and developing within its stems, but that weevil depends on a native-plant shore to overwinter. If the shore is instead covered by rock, seawall or traditional lawn, these weevils will be unavailable for the lake to use as Eurasian Watermilfoil control.

The filtering process and bank stabilization that buffers provide help improve a lake's water quality, including water clarity. Studies in Minnesota, Maine and Michigan have shown that waterfront property value increases for every foot the water clarity of a lake increases. (Krysel et al, 2003).

Figure 12: Example of Inadequate Vegetative Buffer

Figure 13: Example of Adequate Buffer

Natural shoreland buffers serve important cultural functions. They enhance the lake's aesthetics. Studies have shown that aesthetics rank high as one of the reasons people visit or live on lakes. Shore buffers can provide visual & audio privacy screens for homeowners from other neighbors and/or lake users.

Adequate buffers on Upper and Lower Camelot Lakes in some places could be easily installed on the inadequate areas by either letting the first 35 feet landward from the water just grow without mowing it, except for a path to the water, or by planting native seedlings sufficient to fill in the first 35 feet or using biologs to protect the shore that are vegetated. Where areas are deeply eroded, shaping, revegetating and protecting the shores will be necessary to prevent further erosion. Heavy armoring may be necessary to repair and protect the heavily-eroded points which are currently adding significant sediment to the lake.

WATER QUALITY

Between 2004 and 2006, Adams County Land & Water Conservation Department gathered water chemistry and other water quality information on both Upper and Lower Camelot Lakes. Historic information about water testing on the Camelot Lakes was also obtained from the studies discussed earlier in this report.

Phosphorus

Most lakes in Wisconsin, including both Upper and Lower Camelot Lakes, are phosphorus-limited lakes: of the pollutants that end up in the lake, the one that most affects the overall quality of the lake water is phosphorus. The amount of phosphorus especially affects the frequency and density of aquatic vegetation and the frequency and density of various kinds of algae, as well as water clarity and other quality aspects. One pound of phosphorus can produce as much as 500 pounds of algae.

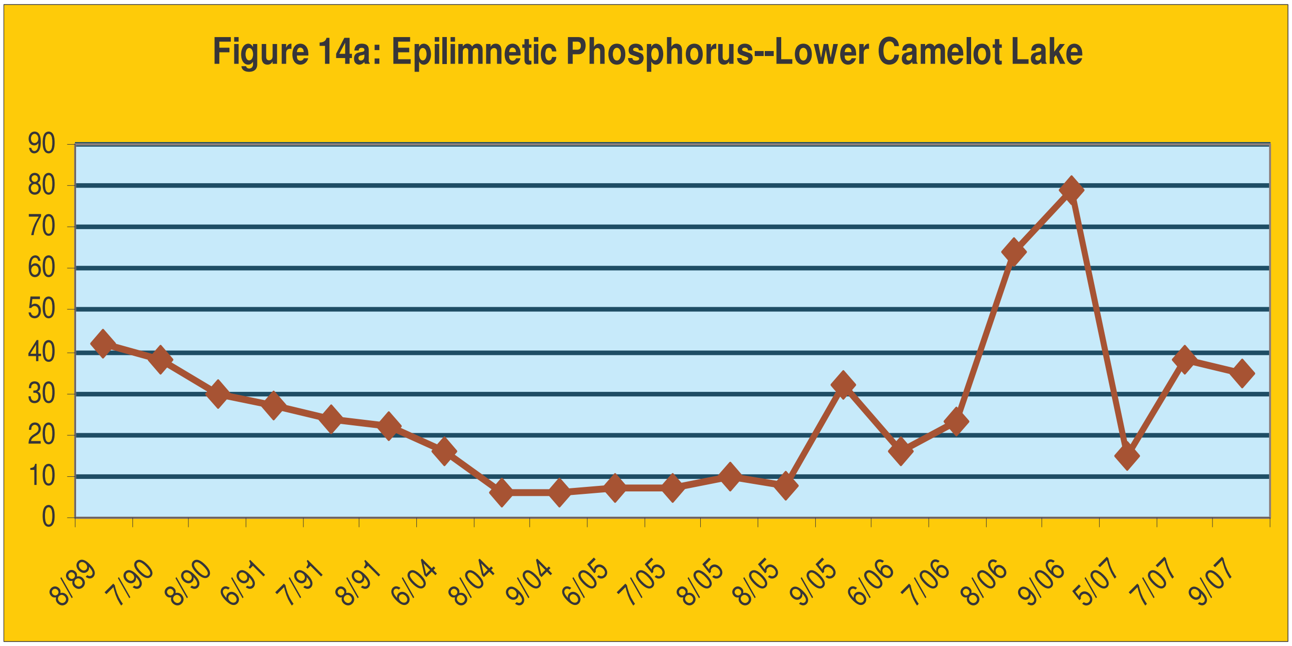
Phosphorus is not an element that occurs in high concentration naturally, so any lake that has significant phosphorus readings must have gotten that phosphorus from outside the lake or from internal loading. Some phosphorus is deposited onto the lake from atmospheric deposition, especially from soil or other particles in the air carrying phosphorus. A lake that includes a flooded wetland area may have a significant amount of phosphorus being released during the flushing of the wetland area. Phosphorus may accumulate in sediments from dying animals, dying aquatic plants and dying algae. If the bottom of the lake becomes anoxic (oxygen-depleted), chemical reactions may cause phosphorus to be released to the water column.

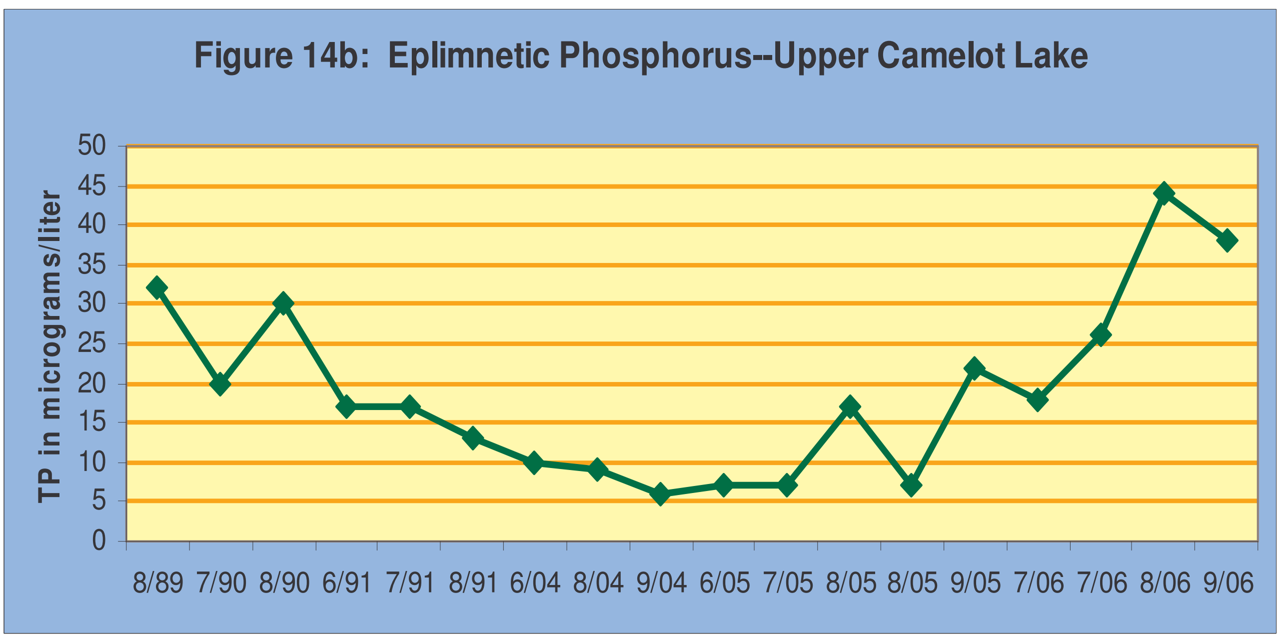
Although there are several forms of phosphorus in water, the total phosphorus (TP) concentration is considered a good indicator of a lake's nutrient status, since the TP concentration tends to be more stable than other types of phosphorus concentration. For an impoundment lake like the two Camelot Lakes, a total phosphorus concentration below 30 micrograms/liter tends to prevent nuisance algal blooms. Upper Camelot Lake's growing season (June 2004-September 2006) surface average total phosphorus level of 16.62 micrograms/liter, under the level at which nuisance algal blooms can be expected. The average growing season total phosphorus in the same period on Lower Camelot Lake was 23.17 micrograms/liter.

Since phosphorus is usually the limited factor, measuring the phosphorus in a lake system thus provides an indication of the nutrient level in a lake. Increased phosphorus in a lake will feed algal blooms and also may cause excess plant growth.

These 2004-2006 summer average total phosphorus concentrations in both Camelot Lakes place them in the "good" water quality level for phosphorus for impoundments.

Figures 14a and 14b show the eplimnetic growing season total phosphorus readings for the Camelot Lakes since 1989.





Although the growing season eplimnetic total phosphorus levels have stayed below the state impoundment average of 65 micrograms/liter, the prior studies on the Tri-Lakes showing increasing phosphorus accumulation below septic fields around the lake and the continued heavy growth of aquatic plants in the lakes suggest that lake surface waters total phosphorus should continue to be monitored and steps should be taken to reduce the phosphorus levels in the lakes.

Groundwater testing of various wells around both Camelot Lakes was done by Adams County LWCD and included a test one year for total phosphorus levels in the groundwater coming into the lake. For Lower Camelot Lake, the average TP level in the wells was 24.3 micrograms/liter, only slightly higher than the lake surface water results. For Upper Camelot Lake, the average total phosphorus level in well water was 23.25 micrograms/liter, about 8 micrograms/liter higher than the surface water levels. These figures don't negate the study results done earlier in the Camelot Lakes' area showing elevated phosphorus below septic fields.

Land use plays a major role in phosphorus loading. A key component of the computer models used is the phosphorus budget, that is, the estimated amount of phosphorus delivered to the lake from each land use type annually. The land uses that contribute the most phosphorus are non-irrigated agriculture and residences. Using the current land use data, as well as phosphorus readings from 2004 through 2006 water sampling, a phosphorus loading prediction model was run for the two Camelot Lakes together. The current results are shown in Figure 15.

Figure 15: Current Phosphorus Loading by Land Use

MOST LIKELY CURRENT PHOSPHORUS LOADING		
	% Total	lbs/yr
Irrigated Agriculture	30.0%	1789
Non-Irrigated Agriculture	19.4%	1157
Grassland/Pasture	0.2%	13
Residential	3.3%	180
Woodlands	2.3%	136
Other Water	0.2%	13
Groundwatershed	29.0%	1727
Lake Surface	1.0%	59
Septics	14.6%	871
total in pounds/year	100.0%	5947

A review of the results of prior studies in the Tri-Lakes area suggest that overall phosphorus loading in the watershed is now less than it was in the early-1990s. This may be due to the installation of agricultural runoff practices in the upper watershed. However, land use distribution figures have also changed, including a significant increase in waterfront building around the lakes. Current estimated phosphorus loading is only about 50% of what it was in 1978.

Currently, the most phosphorus loading is coming from human use in the surface watershed, including medium-density housing, septic systems and agricultural uses. Although phosphorus deposits such as that from flooded wetlands or from atmospheric deposition cannot be controlled by humans, phosphorus loads from human activities such as agriculture, residential development, recreational and septic systems can be partly controlled by changes in human land use patterns. Practices such as agricultural buffers, nutrient management, shoreland buffer restoration; infiltrating stormwater runoff from roof tops, driveways and other impervious surfaces; using no phosphorus lawn fertilizers; and reducing phosphorus input to and properly managing septic systems will minimize phosphorus inputs into the lake. Circumstances such as increased impervious surface, lawns mowed to water's edge, disturbance of shore areas, improperly-functioning septic systems and removal of native vegetation can greatly increase the volume and content of runoff—and thus increase the <u>volume</u> of phosphorus entering the lake. Many of these practices can also increase the <u>concentration</u> of phosphorus entering the lake, by runoff or other methods of entry.

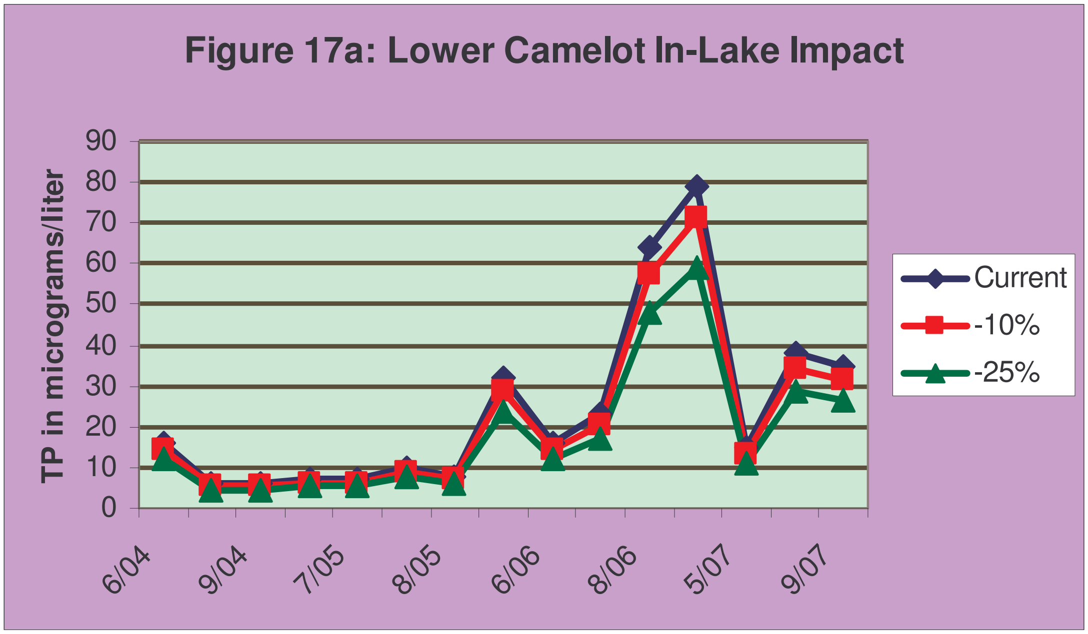
The models were run using not only the current known phosphorus readings in the lake, but also representing decreases or increases of human-controlled phosphorus input by 10%, 25%, and 50%. Just a 10% reduction of the human-impacted phosphorus would reduce the overall load by 1901 pounds/year. This figure may not seem like much---until you calculate that one pound of phosphorus can result in up to 500 pounds of algae. A 10% reduction in these three areas could result in up to 950,500 pounds <u>less</u> of algae per year!

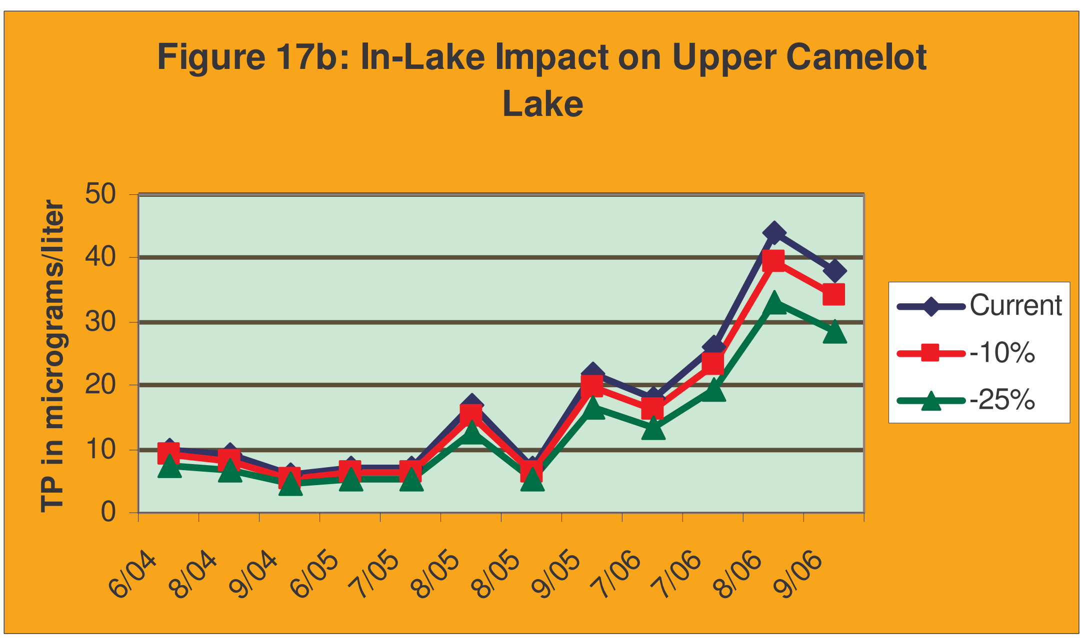
Figure 16: Impact of Increase/Decrease on P Loading

MOST LIKELY CURRENT PHOSPHORUS LOADING				
	lbs/yr	-10%	-25%	-50%
Irrigated Agriculture	1789	282.6	1341.45	894.3
Non-Irrigated Agriculture	1157	1041.48	236.25	578.6
Grassland/Pasture	13	13	13	13
Residential	180	162.36	135.3	90.2
Woodlands	136	136	136	136
Other Water	13	13	13	13
Groundwatershed	1727	1554.3	1295.25	160
Lake Surface	59	59	59	59
Septics	871	784.08	653.4	435.6
total in pounds/year	5947	4046	3883	2380

Reducing the amount of input from the surface and ground watersheds results in less nutrient loading into the lake itself. Under the modeling predictions, reducing phosphorus inputs from human-based activities even 10% would improve Lower

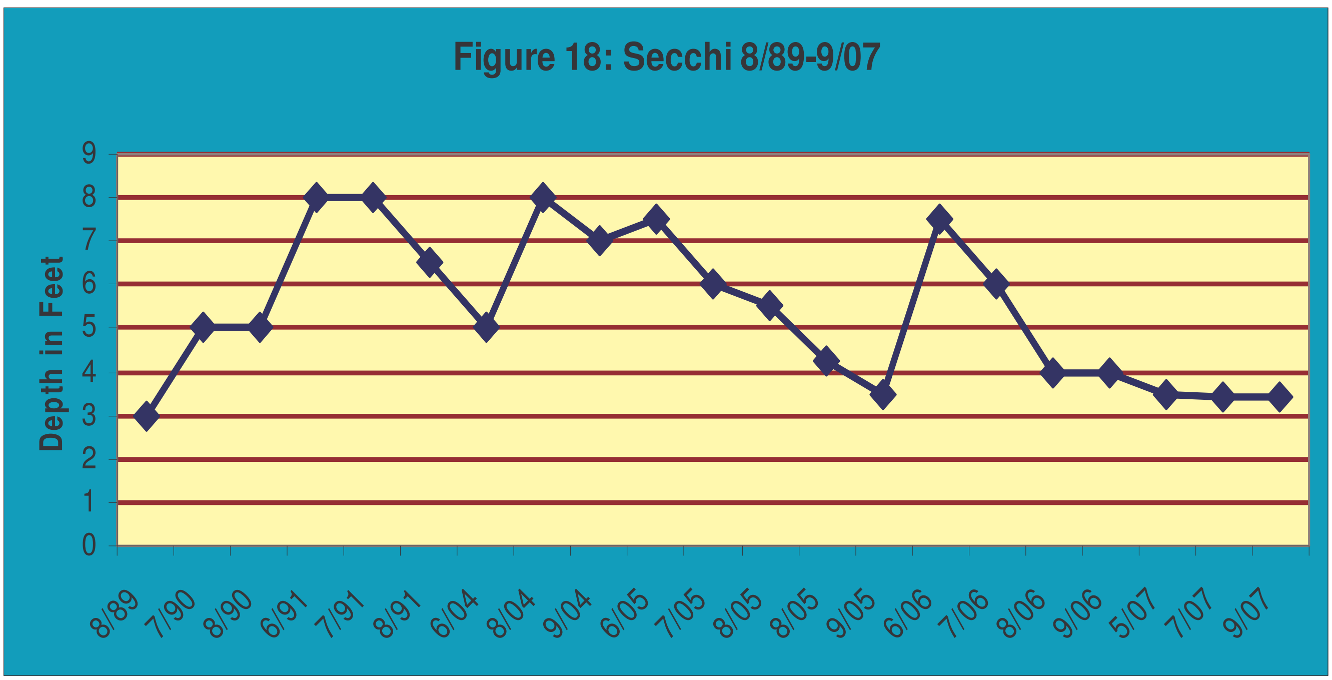
Camelot Lake water quality by .6 to 7.9 micrograms/liter and Upper Camelot Lake water quality .7 to 5.4 micrograms/liter. A 25% reduction would save 1.5 to 16 micrograms/liter during the growing season on Lower Lake Camelot and 1.75 to 11 micrograms/liter on Upper Camelot Lake. These predictions make it clear that reducing current phosphorus inputs to the lake are essential to maintain and protect the water health of the two Camelot Lakes for future generations.





Water Clarity

Water clarity is a critical factor for plants. If plants don't get more than 2% of the surface illumination, they won't survive. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity is measured with a Secchi disk. Average summer Secchi disk clarity in Lower Camelot Lake in 2004-2006 was 5.54 feet, in the "fair" category for water clarity. The Secchi disk average for the growing season in the 1990s was 5.9 feet. These figures suggest that Lower Camelot Lake's water clarity has stayed fairly steady for the last twenty years, i.e., it didn't substantially decrease or substantially increase. Water clarity can be reduced by turbidity (suspended materials such as algae and silt) and dissolved organic chemicals that color or cloud the water. Water clarity often gets worse during the growing season due to increase in algae & other pollutants in the water, then clears up again by fall turnover.



Upper Camelot Lake tends to have slightly clearer water than Lower Camelot Lake, perhaps because much of the water it receives has been "filtered" through Lower Camelot Lake and Camelot Channel. Its growing season average Secchi reading between 2004 to 2006 was 6.19 feet, in the "good" category for water clarity.

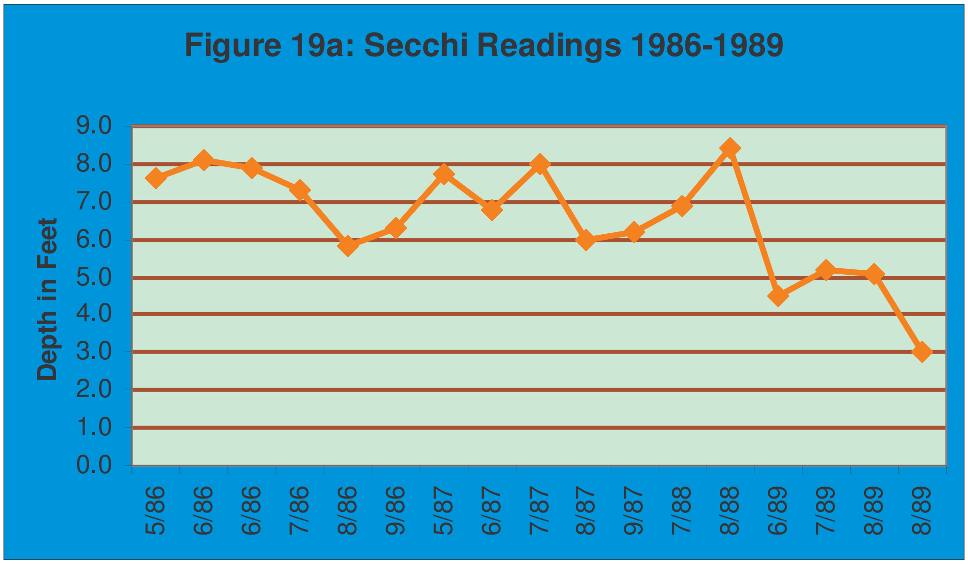


Figure 19a: Secchi Readings 1986-1989
Depth in Feet
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
5/86
6/86
6/86
7/86
8/86
9/86
5/87
6/87
7/87
8/87
9/87
7/88
8/88
6/89
7/89
8/89
8/89

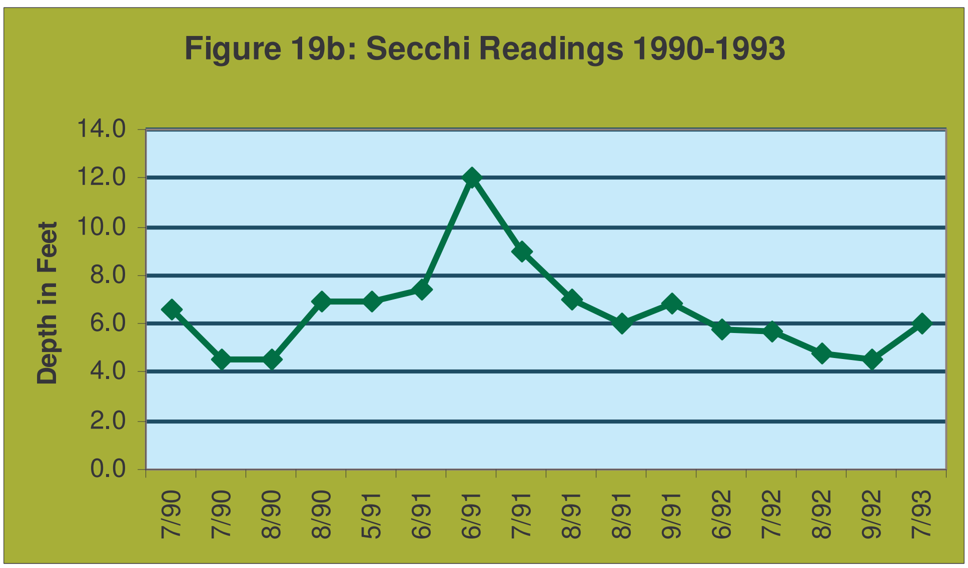


Figure 19b: Secchi Readings 1990-1993
Depth in Feet
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
7/90
7/90
8/90
8/90
5/91
6/91
6/91
7/91
8/91
8/91
9/91
6/92
7/92
8/92
9/92
7/93

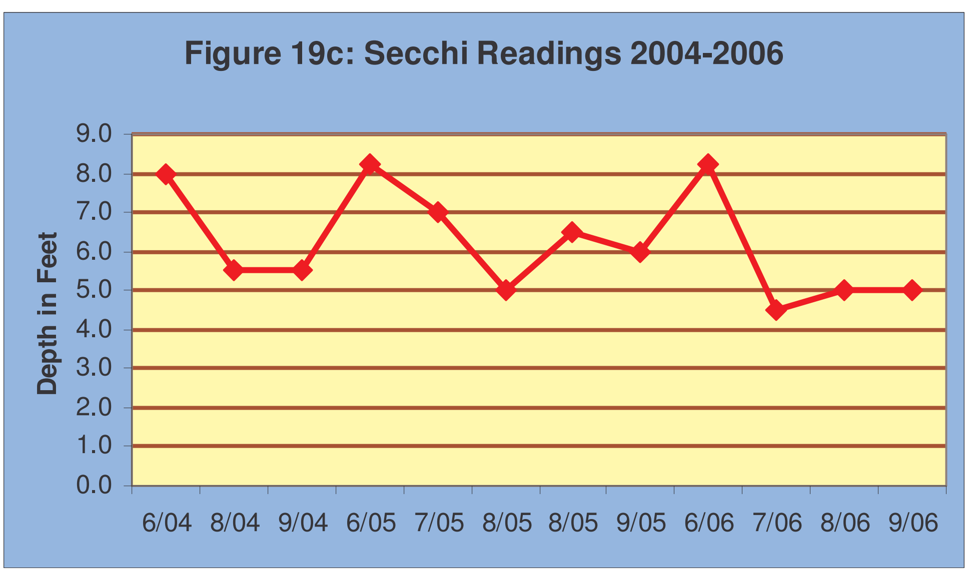


Figure 19c: Secchi Readings 2004-2006
Depth in Feet
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
6/04
8/04
9/04
6/05
7/05
8/05
8/05
9/05
6/06
7/06
8/06
9/06

Upper Camelot Lake has a considerable history of Secchi disk readings in a number of years. A look at the average Secchi depth for the growing season in each year since 1986, Secchi disk depth readings on Upper Camelot Lake show a slight downward trend over the years (see figure 20). However, the overall average depth for the twenty years is 6.24 feet, only slightly above the growing season average of 6.19 feet for 2004-2006.

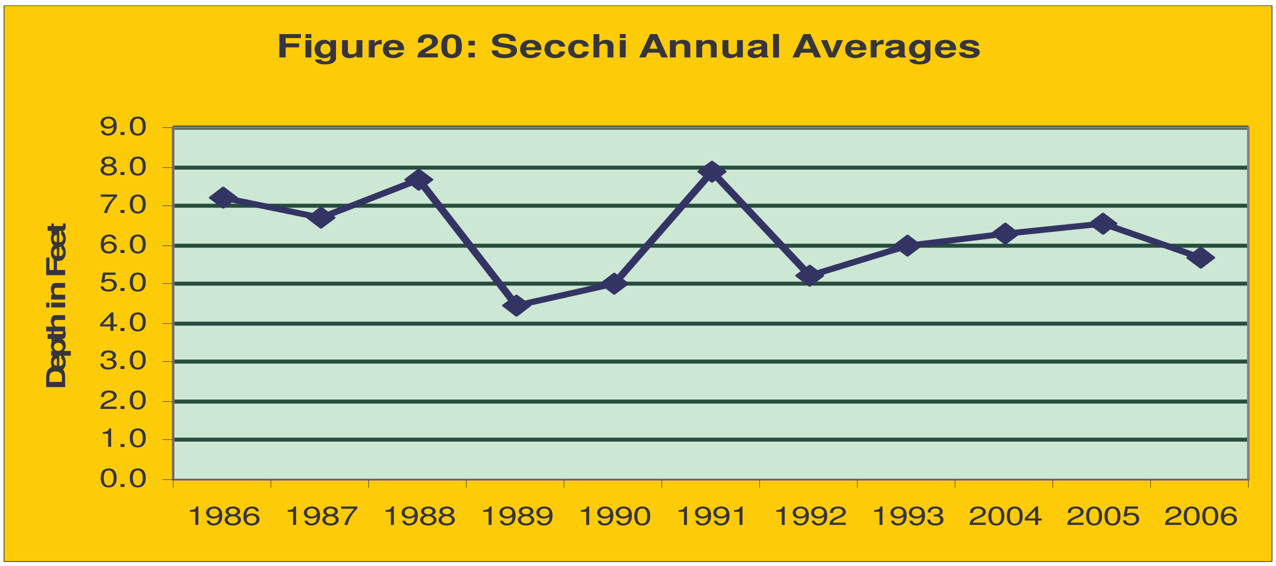
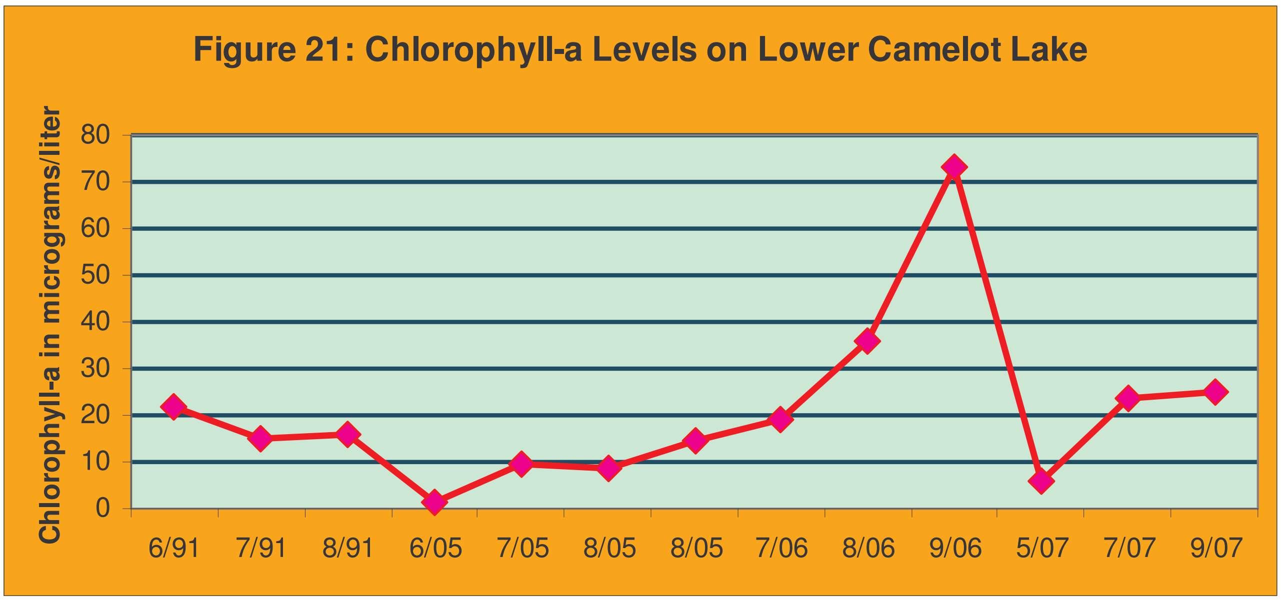
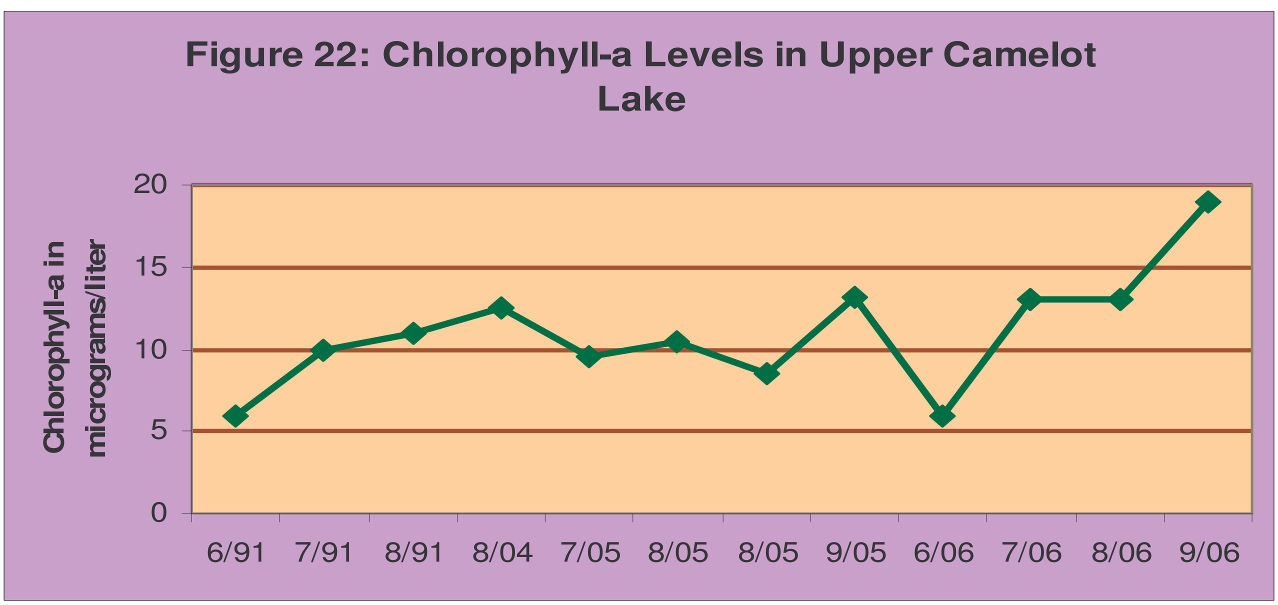


Figure 21: Photo of Testing Water Clarity with Secchi Disk

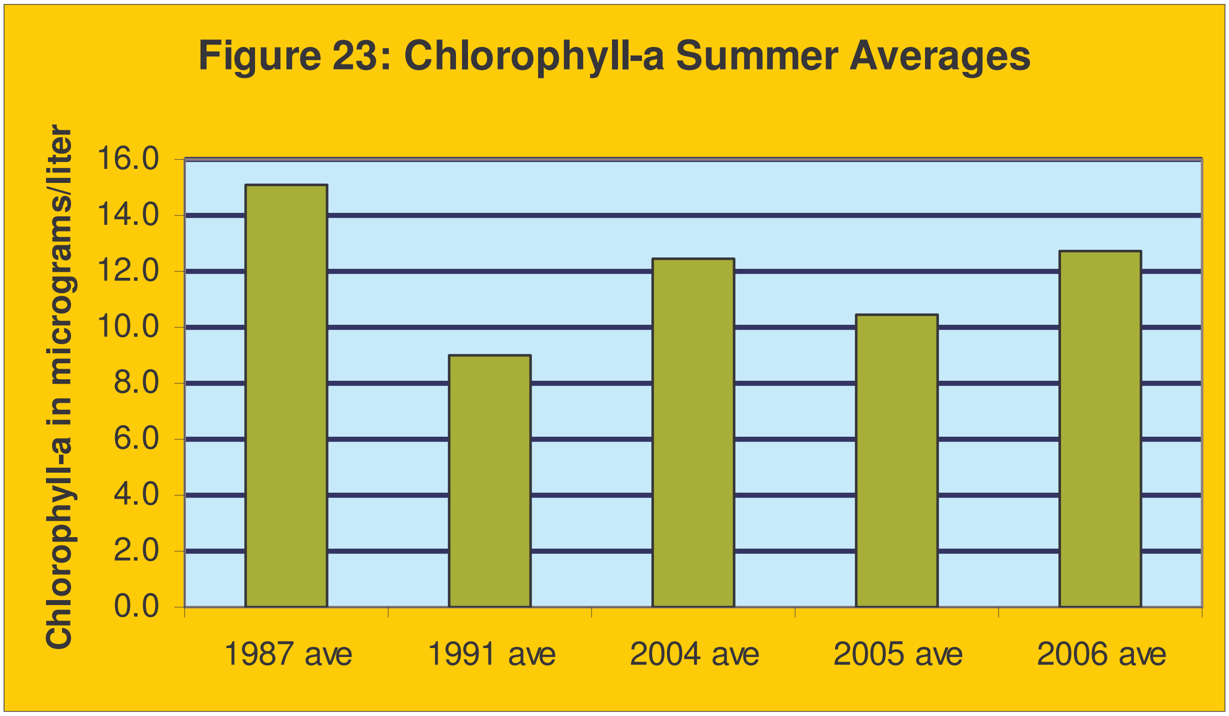
Chlorophyll a

Chlorophyll-a concentrations provide a measurement of the amount of algae in a lake's water. Algae are natural and essential in lakes, but high algal populations can increase water turbidity and reduce light available for plant growth, as well as result in unpleasing odor and appearance. Studies have shown that the amount of chlorophyll a in lake water depends greatly on the amount of algae present; therefore, chlorophyll-a levels are commonly used as a water quality indicator. The 2004-2006 growing season (June-September) average chlorophyll concentration in Lower Camelot Lake was 15.53 micrograms/liter, in the "poor" category for chlorophyll-a levels. Average for Upper Camelot Lake was 11.9 micrograms/liter, in the "fair" category.





Records for Upper Camelot Lake are more extensive than those for Lower Camelot Lake. A view of the chlorophyll-a averages since 1987 don't suggest that there is a substantial change in the level since then.



Dissolved Oxygen

Oxygen dissolved in the water is essential to all aerobic aquatic organisms. The oxygen in a lake comes from the atmosphere and from the process of photosynthesis. Aquatic plants and algae consume carbon dioxide and respirate oxygen back into the lake water. The distribution of oxygen within a lake is affected by many factors, including water circulation, water stratification, winds or storms, air temperature; water temperature, nutrient availability, and the density and location of algae and/or aquatic plants.

Prior studies of the Camelot Lakes have found anoxic (no oxygen) or hypoxic (low oxygen) in the lakes. During the 2004-2006 study, hypoxia was found on Upper Camelot Lake in August 2004 and June 2006 and on Lower Camelot Lake in August 2005. Otherwise, dissolved oxygen levels didn't usually go below levels 5 milligrams/liter, the appropriate level for good fish survival. The charts (Figures 24 and 25) show the annual variations in dissolved oxygen levels in milligrams/liter, depth in feet and months of the years.

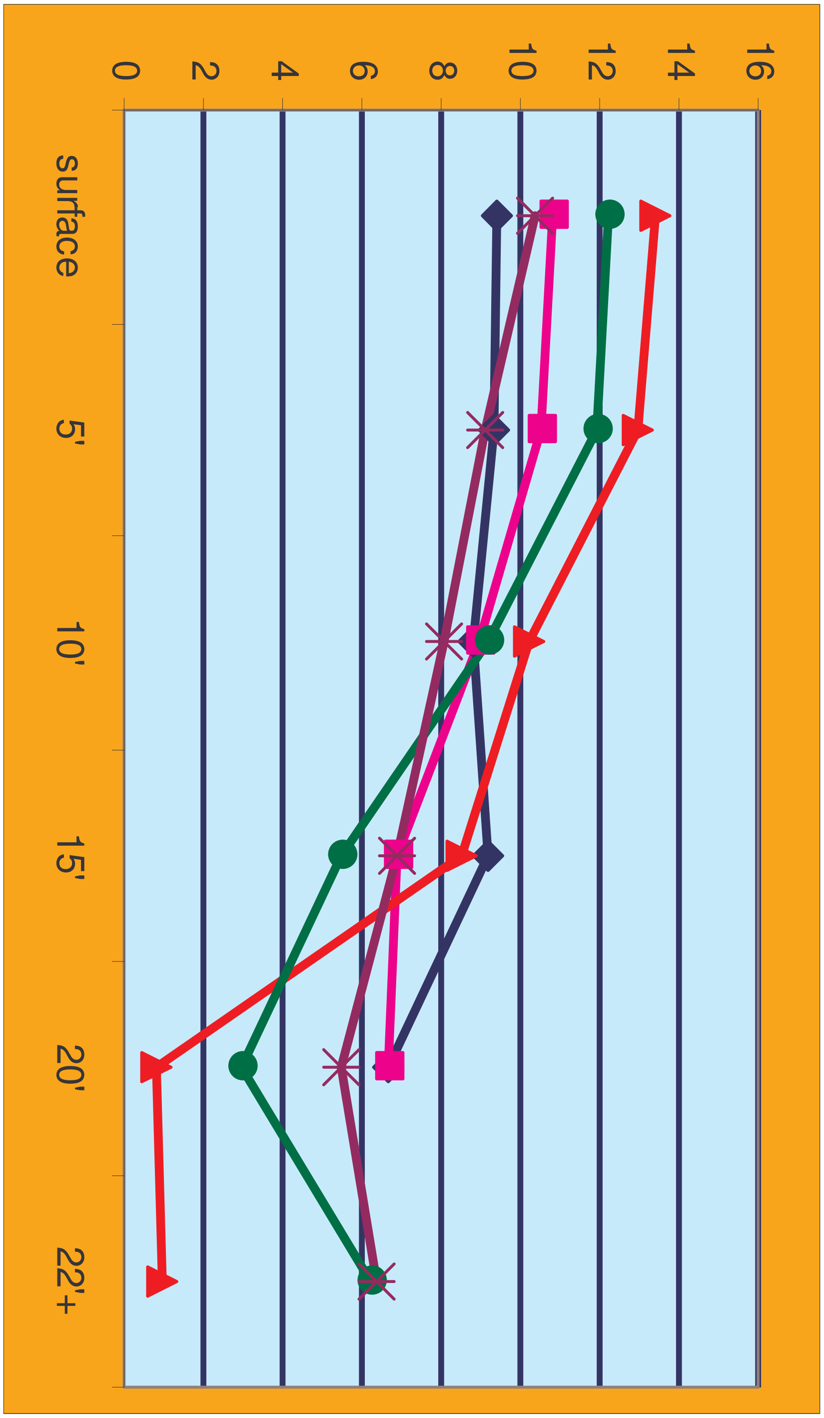
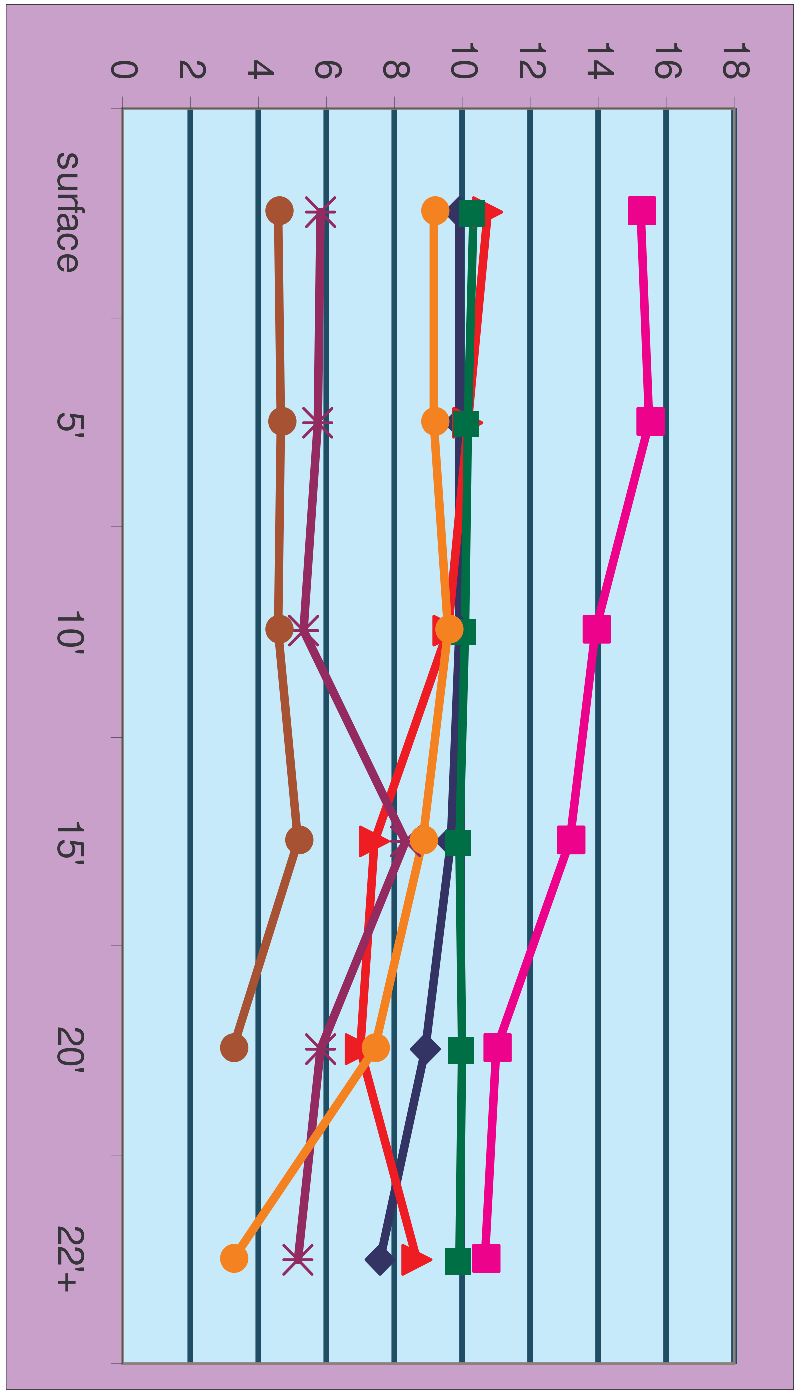
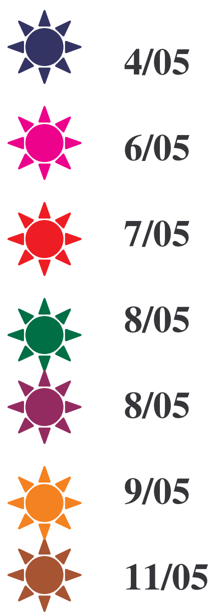


Figure 24a: Dissolved Oxygen Levels 2004 in milligrams/liter—Upper Camelot Lake

Figure 24b: Dissolved Oxygen Levels During 2005 Water Testing in milligrams/liter—Upper Camelot Lake





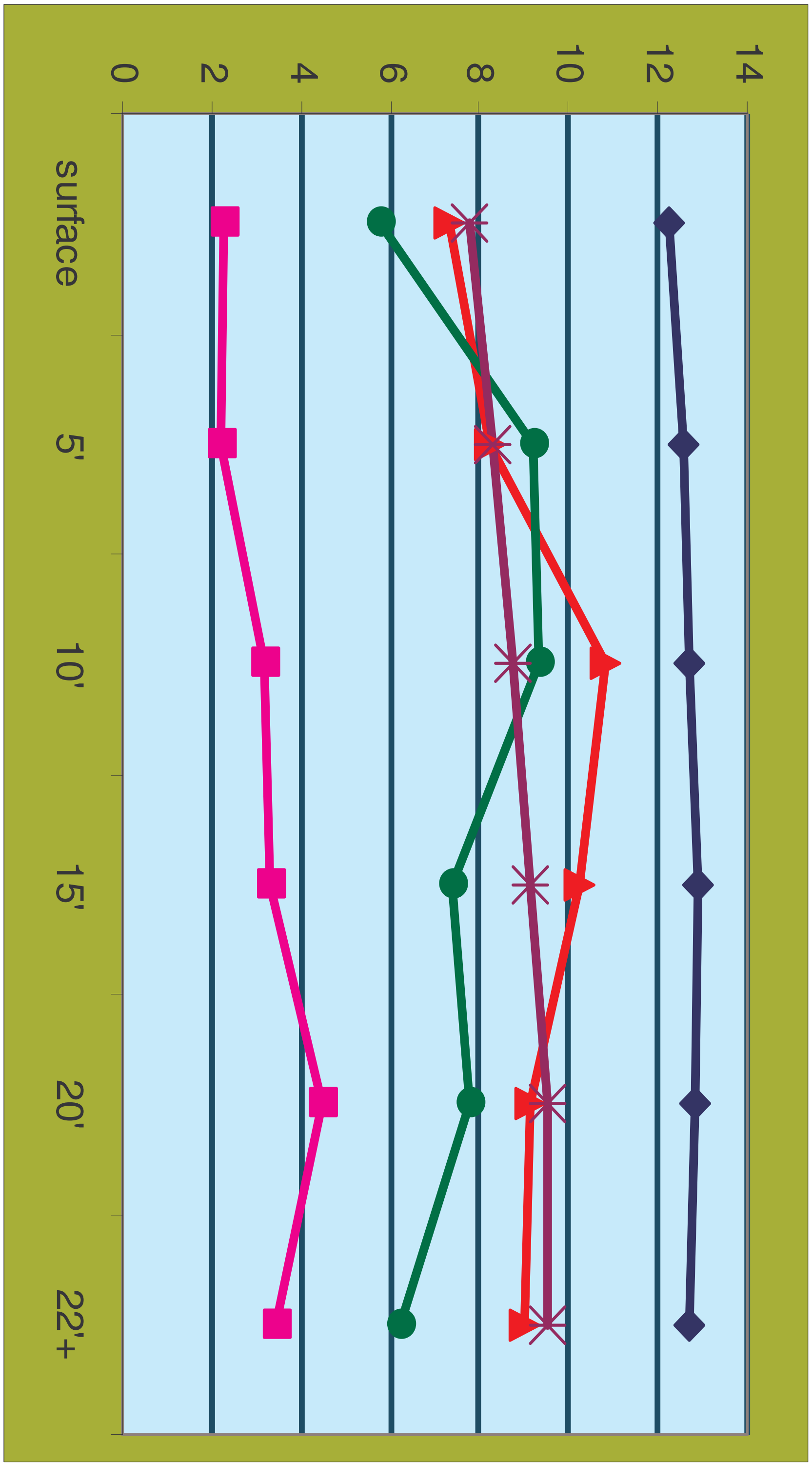


Figure 245c: Dissolved Oxygen Levels During 2006Water Testing in milligrams /liter—Upper Camelot Lake

4/05

6/05

7/05

8/05

9/05

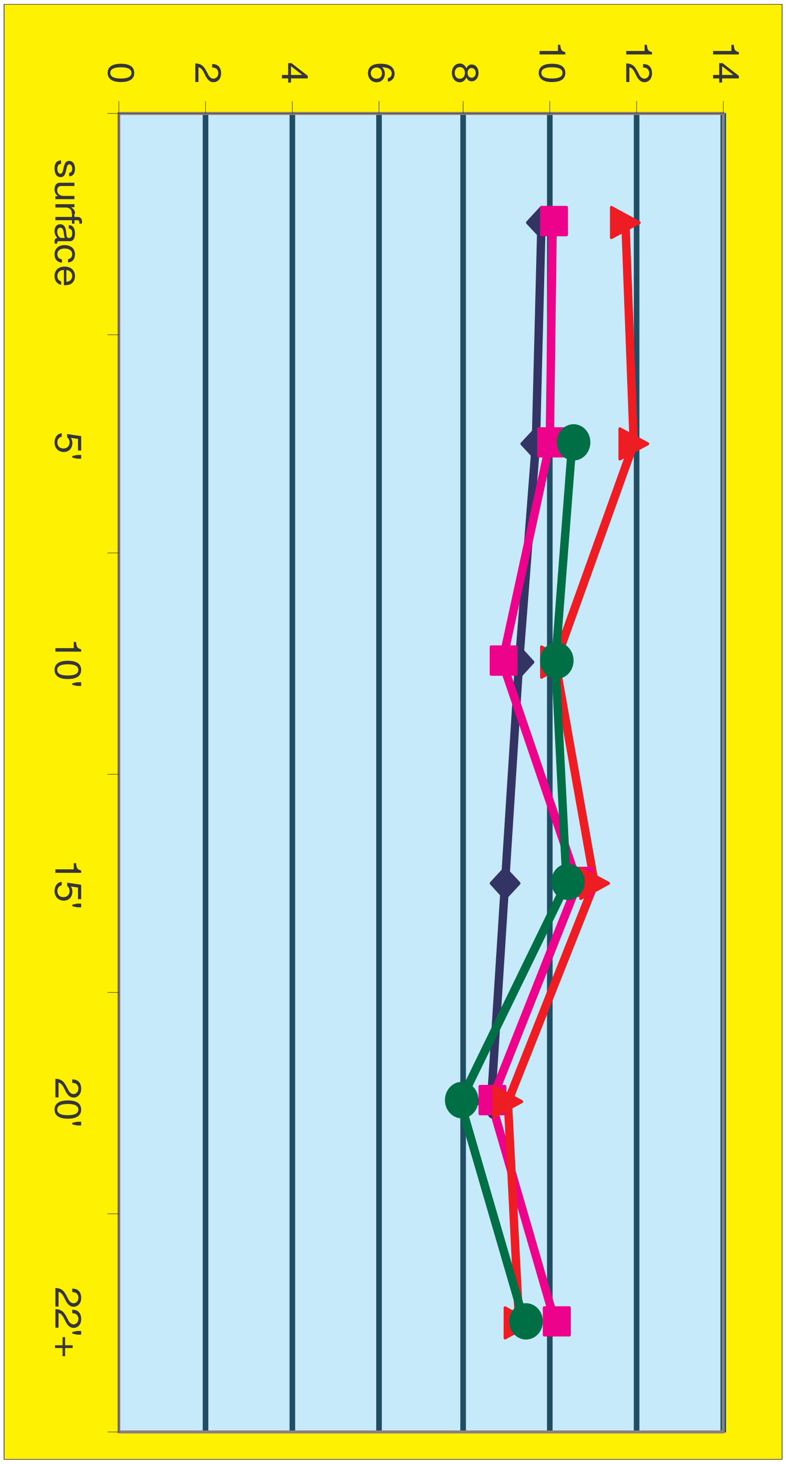


Figure 25a: Dissolved Oxygen Levels 2004 in milligrams/liter— Lower Camelot Lake

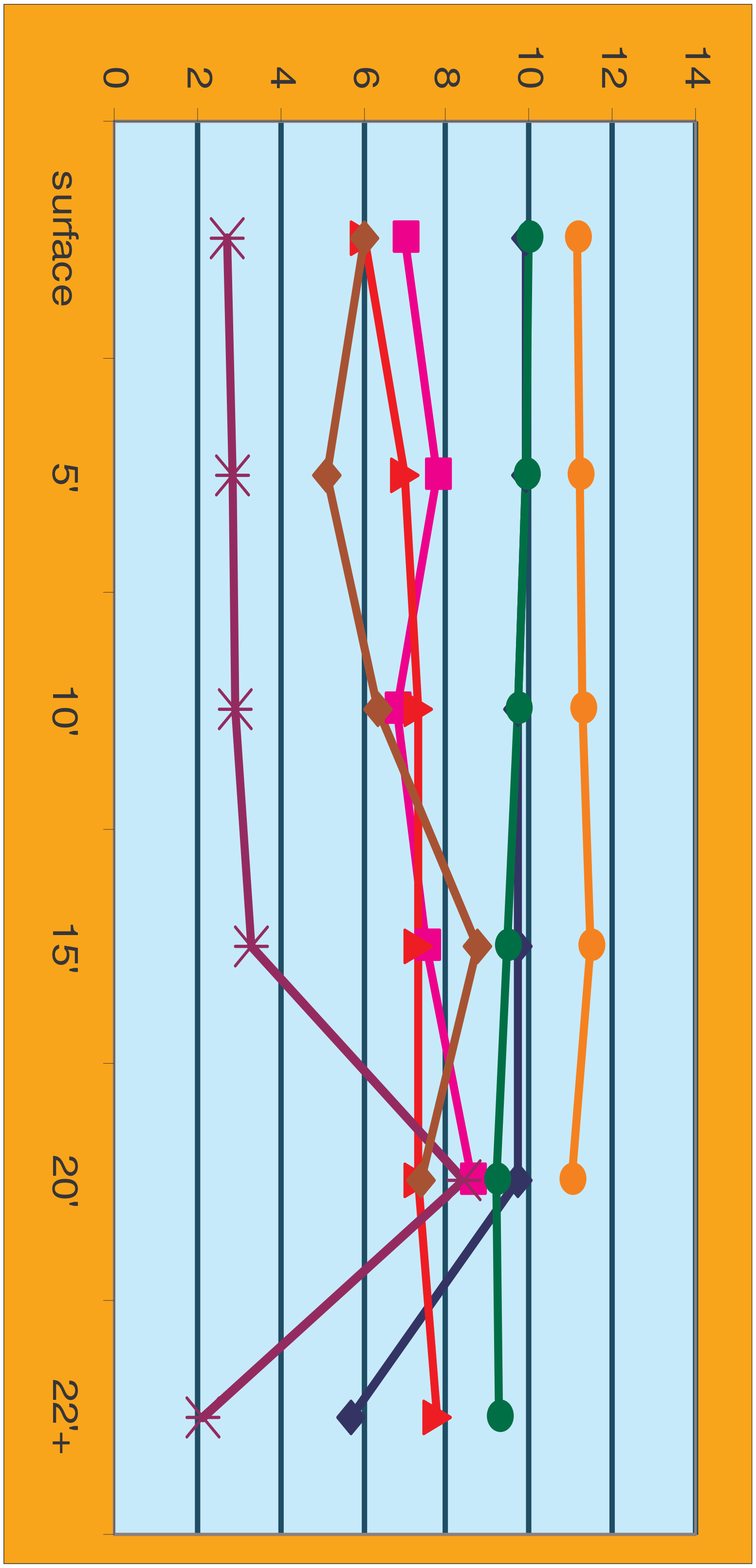


Figure 25b: Dissolved Oxygen Levels 2005 in milligrams/liter—Lower Camelot Lake

4/05

6/05

7/05

8/05

8/05

9/05

11/05

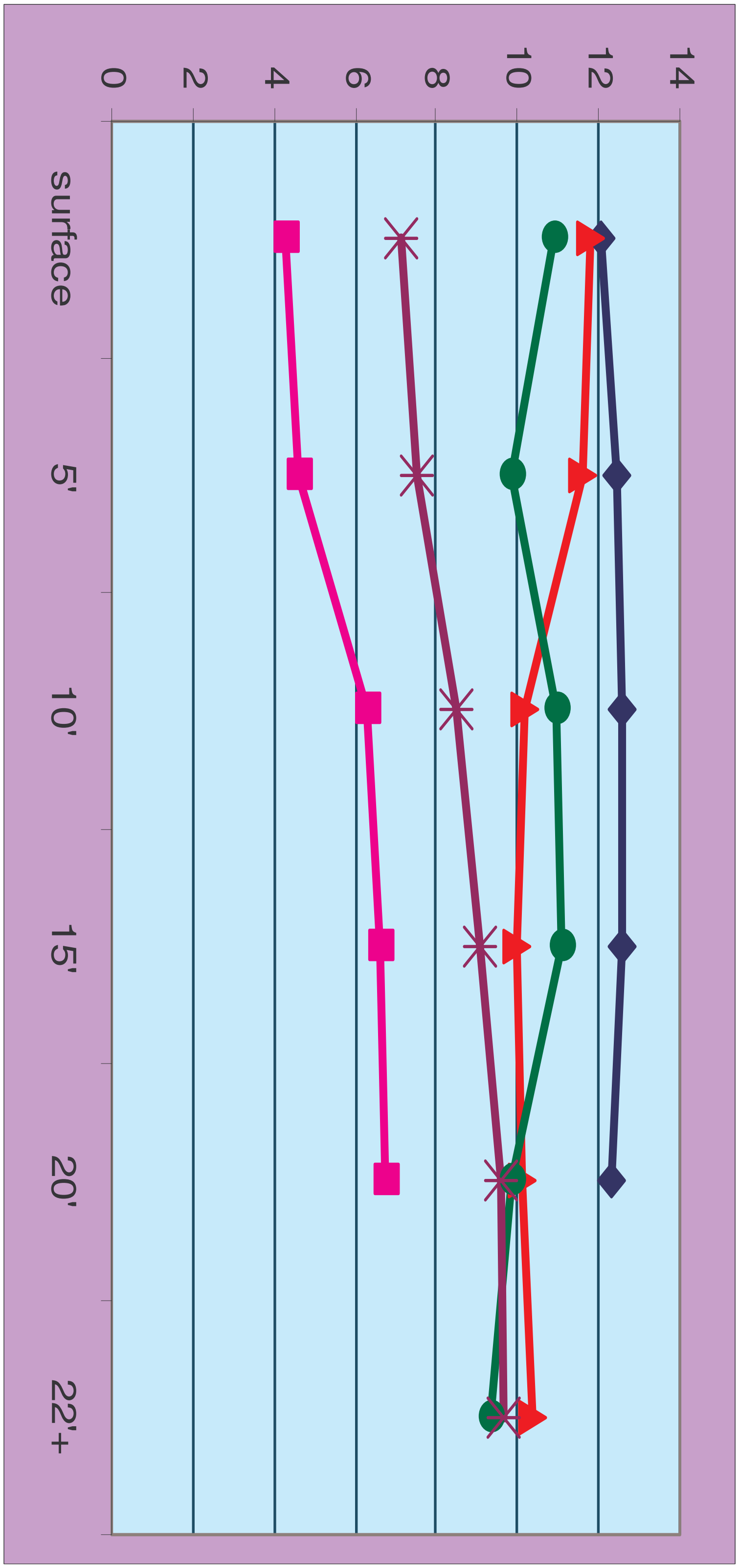


Figure 25c: Dissolved Oxygen Levels 2006 in milligrams/liter—Lower Camelot Lake

4/06
6/06
7/06
8/06
9/06

In deeper lakes, when the surface waters have cooled in autumn and water density throughout the water column is the same, the water column mixes vertically, a process known as “fall turnover.” Most parts of the Camelot Lakes are shallow and do not stratify. However, the deeper areas near the two dams do stratify and turn over in the spring or fall.

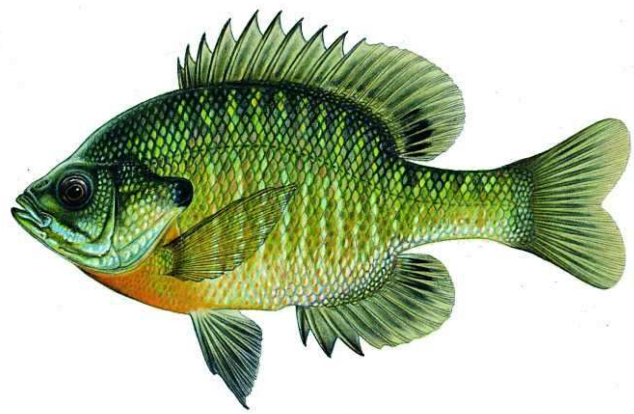


Figure 26a: One of the abundant fish in the Camelot Lakes—Bluegill (*Lepomis macrochirus*)

Figure 26b: One of the common Fish in the Camelot Lakes—Largemouth Bass (*Micropterus salmoides*)

Figure 27: Photo of a Lake in Algal Bloom

Water Hardness, Alkalinity and pH

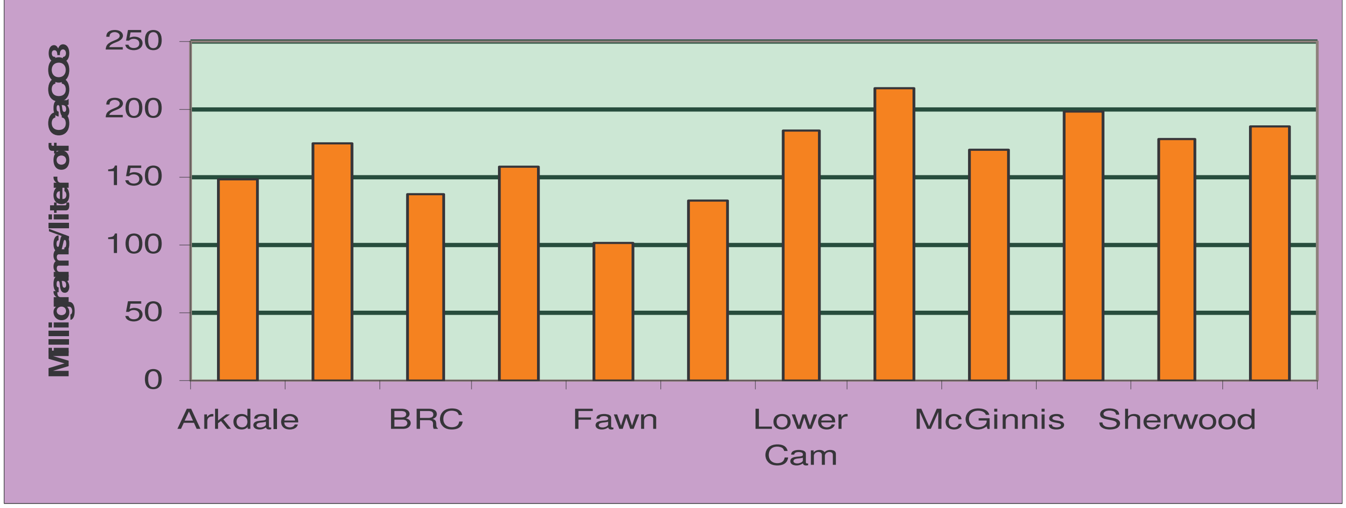
Testing done by Adams County LWCD on the Camelot Lakes included annual testing for water alkalinity and water hardness. Hardness and alkalinity levels in a lake are affected by the soil minerals, bedrock type in the watershed, and frequency of contact between lake water & these materials.

Level of Hardness	Milligrams/liter CaCO3
SOFT	0-60
MODERATELY HARD	61-120
HARD	121-180
VERY HARD	>180

Figure 28: Hardness Table

One method of evaluating hardness is to test the water for the amount of calcium carbonate (CaCO3) it contains. The surface water of all of the public access lakes in Adams County have water that is moderately hard to very hard, whether they are impoundments (man-made lakes) or natural lakes. In 2005 and 2006, random samples were also taken of wells around the two Camelot Lakes to measure the hardness of the water coming into the lakes through groundwater. Hardness in the groundwater averaged 168.5 milligrams/liter for Lower Camelot Lake and 172.29 milligrams/liter for Upper Camelot Lake. Surface water hardness for Lower Camelot Lake averaged 184 milligrams/liter, slightly higher than the groundwater hardness. The same pattern was present in Upper Camelot Lake, where the surface water hardness average was 187 milligrams/liter, slightly higher then the groundwater hardness. The hardness in both surface and groundwater is likely due to the underlying bedrock in Adams County, which is mostly sandstone with pockets of dolomite and shale.

Figure 29: Impoundment Hardness



Both Camelot Lakes' surface water averages for hardness were slightly higher than the county surface water average hardness for impoundments in Adams County of 166 milligrams/liter of Calcium Carbonate. Hard water lakes tend to produce more fish and aquatic plants than soft water lakes because they are often located in watersheds with soils that load phosphorus into the lake water.

Alkalinity is important in a lake to buffer the effects of acidification from the atmosphere. "Acid rain" has long been a problem with lakes that had low alkalinity level and high potential sources of acid deposition.

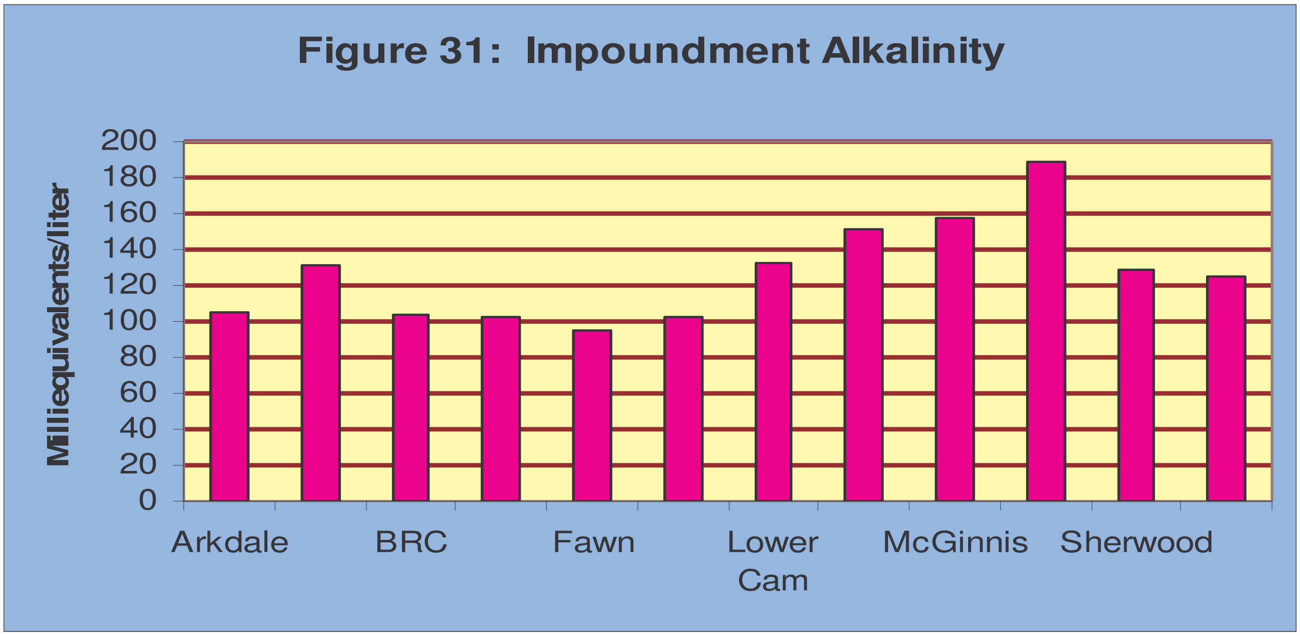
Acid Rain Sensitivity	ueq/l CaCO3
High	0-39
Moderate	49-199
Low	200-499
Not Sensitive	>500

Figure 30: Acid Rain Sensitivity

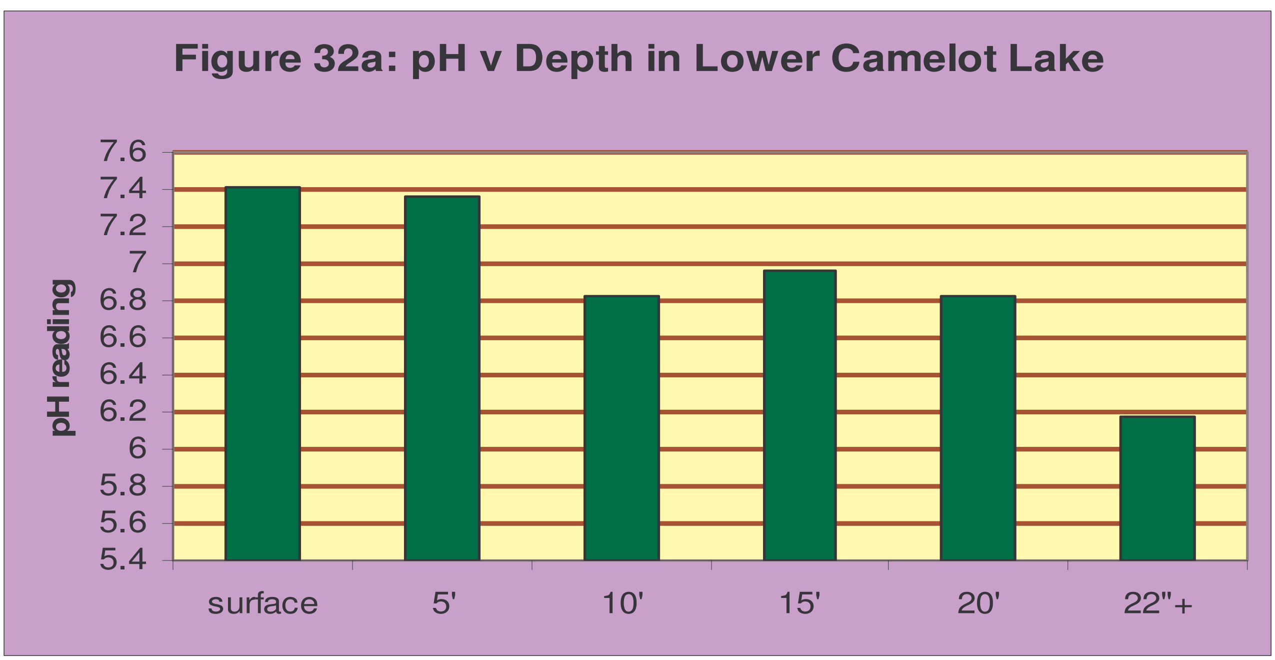
Well water alkalinity testing results averaged 197 milliequivalents/liter for Lower Camelot Lake and 170 milliequivalents/liter for Upper Camelot Lake. Both of these figures than the surface water averages of 126.4 milliequivalents/liter for Lower Camelot and 119.2 milliequivalents/liter for Upper Camelot. The lakes have moderate potential sensitivity to acid rain, but luckily for Adams County, the acid deposition rate is very low, probably due to the little industrialization in the county.

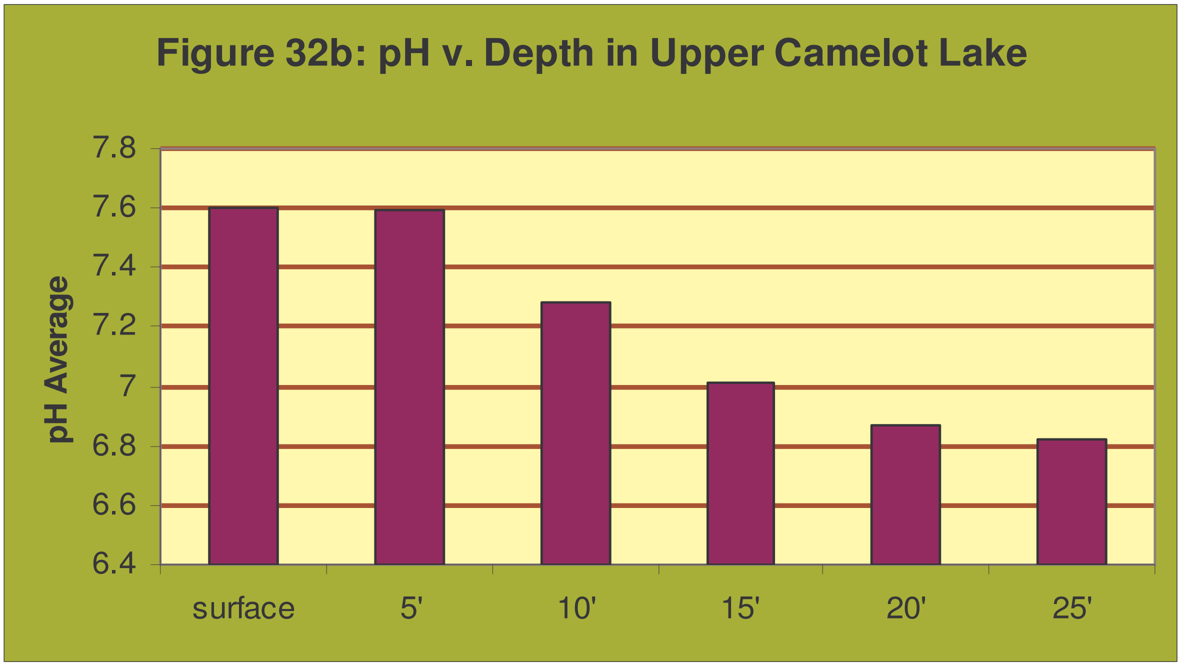
Alkalinity also affects the pH level of lake water. The acidity level of a lake's water regulates the solubility of many minerals. A pH level of 7 is neutral. The pH level in Wisconsin lakes ranges from 4.5 in acid bog lakes to 8.4 in hard water, marl lakes.

Some of the minerals that become available under low pH, especially the metals aluminum, zinc and mercury, can inhibit fish reproduction and/or survival. Even what seems like a small variance in pH can have large effects because the pH scale is set up so that every 1.0 unit change increases acidity tenfold, i.e., water with a pH of 7 is 10 times more acid than water with pH of 8. Mercury and aluminum are not only toxic to many kinds of wildlife; they can also be toxic to humans, especially those that eat tainted fish.



The testing occurring from 2004-2006 also included regular monitoring of the pH at several depths in for the two Camelot Lakes. As is common in the lakes in Adams County, they have pH levels starting at just over neutral at over 22 feet depth and increasing in alkalinity as the depth gets less. A lake's pH level is important for the release of potentially harmful substances and also affects plant growth, fish reproduction and survival. Most plants grow best at pH levels between 5.5 and 8.





More importantly for many lakes, fish reproduction and survival are very sensitive to pH levels. The chart below indicates the effect of pH levels under 6.5 on fish (Figure 33):

Figure 33: Effects of pH Levels on Fish

Water pH	Effects
6.5	walleye spawning inhibited
5.8	lake trout spawning inhibited
5.5	smallmouth bass disappear
5.2	walleye & lake trout disappear
5	spawning inhibited in most fish
4.7	Northern pike, sucker, bullhead, pumpkinseed, sunfish & rock bass disappear
4.5	perch spawning inhibited
3.5	perch disappear
3	toxic to all fish

No pH levels taken in the two Camelot Lakes between 2004-2006 fell below the pH level that inhibits walleye reproduction. A lake with a neutral or slightly alkaline pH like these lakes is a good lake for fish and plant survival. Natural rainfall in Wisconsin averages a pH of 5.6. This means that if the rain falls on a lake without sufficient alkalinity to buffer that acid water coming in by rainfall, the lake's fish cannot reproduce. That is not a problem at these lakes.

Other Water Quality Testing Results

CHLORIDE: Chloride does not affect plant and algae growth and is not known to be harmful to humans. It isn't common in most Wisconsin soils and rocks, so is usually found only in very low levels in Wisconsin lakes. However, the presence of a significant amount of chloride over a period of time indicates there may be negative human impacts on the water quality present from septic system failure, the presence of fertilizer and/or waste, deposition of road-salt, and other nutrients. An increased chloride level is thus an indication that too many nutrients are entering the lake, although the level has to be evaluated compared to the natural background data for chloride. The average chloride level during the 2004-2006 testing period was 11.16 milligrams/liter in Lower Camelot Lake and 11.7 milligrams/liter in Upper Camelot Lake. Both of these are elevated substantially above the natural level of 3 milligrams/liter for chloride in this area of Wisconsin. Further investigation needs to be performed as to the causes of such continued chloride elevations.

NITROGEN: Nitrogen is necessary for plant and algae growth. A lake receives nitrogen in various forms, including nitrate, nitrite, organic, and ammonium. In Wisconsin, the amount of nitrogen in a lake's water often corresponds to the local land use. Although some nitrogen will enter a lake through rainfall from the atmosphere, that coming from land use tends to be in higher concentrations in larger amounts, coming from fertilizers, animal and human wastes, decomposing organic matter, and surface runoff. For example, the growth level of the exotic aquatic plant, Eurasian Watermilfoil (*Myriophyllum spicatum*) has been correlated with fertilization of lake sediment by nitrogen-rich spring runoff.

Nitrogen levels can affect other aspects of water quality. The sum of water testing results for nitrate, nitrite and ammonium levels of over .3 milligrams/liter in the spring can be used to project the likelihood of an algal bloom in the summer (assuming sufficient phosphorus is also present). Lower Camelot Lake combination spring levels from 2004 to 2006 averaged 1.39 milligrams/liter, far above the .3 milligrams/liter predictive level for nitrogen-related algal blooms. The average for Upper Camelot Lake was 1.54 milligrams/liter, also substantially elevated. These elevations suggest that some of the algal blooms on the Camelot Lakes may be at least partly nitrogen-related.

CALCIUM and MAGNESIUM: Calcium is required by all higher plants and some microscopic lifeforms. Magnesium is needed by chlorophyllic plants and by algae, fungi and bacteria. Both calcium and magnesium are important contributors to the hardness of a lake's waters. Magnesium elevated about 125 milligrams/liter may have a laxative effect on some humans. Otherwise, no health hazards to humans and wildlife are known from calcium and magnesium. The average Calcium level in on Lower Camelot Lake's water during the testing period was 43.35 milligrams/liter and for Upper Camelot Lake was 38.85 milligrams/liter. The average Magnesium level was 17.84 milligrams/liter for Lower Camelot Lakes. It was 16.9 milligrams/liter for Upper Camelot Lake. All of these are low-level readings.

SODIUM AND POTASSIUM: These elements occur naturally only in low levels in Wisconsin waters and soils. Their presence may indicate human-caused pollution. Sodium is found with chloride in many road salts and fertilizers and is also found in human and animal waste. Potassium is found in many fertilizers and also found in animal waste. The level of these two is generally not useful as a specific pollution indicator, but increasing levels or one or both of these elements can indicate possible contamination from damaging pollutants. High levels of sodium have also been found to influence the development of a large population of cyanobacteria, some of which can be toxic to animals and humans. Some health professionals have suggested that sodium levels over 20 milligrams/liter may be harmful to heart and kidney patients if ingested. From 2004-2006, the average sodium level was 3.1 milligrams/liter for both Lower Camelot and Upper Camelot Lakes. The average potassium reading from 2004 to 2006 was 2.78 milligrams/liter for Lower Camelot Lake and 2.6 milligrams/liter for Upper Camelot Lake. Both of these reading remain low on the overall scale of potential problems.

SULFATE: In low-oxygen waters (hypoxic), sulfate can combine with hydrogen and becomes the gas hydrogen sulfate, which smells like rotten eggs and is toxic to most aquatic organisms. Sulfate levels can also affect the metal ions in the lake, especially iron and mercury, by binding them up, thus removing them from the water column. To prevent the formation of hydrogen sulfate, levels of 10 milligrams/liter are best. A health advisory kicks in at 30 milligrams/liter. Lower Camelot Lake sulfate levels averaged 28.83 milligrams/liter during the testing period, above the level for hydrogen sulfate formation, but still slightly below the health advisory level. Upper Camelot Lake averaged 33.7 milligrams/liter, above both the hydrogen sulfate formation level and the health advisory level.

TURBIDITY: Turbidity reflects water clarity. The term refers to suspended solids in the water column—solids that may include clay, silt, sand, plankton, waste, sewage and other pollutants. Turbid water may mask the presence of bacteria or other pollutants because the water looks murky or muddy. In general, turbidity readings of less than 5 NTU are best. Very turbid waters may not only smell, but also tend to be aesthetically displeasing, thus curtailing recreational uses of the water. Turbidity levels for the two Camelot Lake waters were all below the 5 NTU level. The average for Lower Camelot Lake was 2.72 NTU; the average for Upper Camelot Lake was 2.11 NTU.

Figure 34: Examples of Very Turbid Water

HYDROLOGIC BUDGET

According to the WDNR bathymetric (depth) maps, the two Camelot Lakes have 446 surface acres, and the volume of the two lakes is 4196 acre-feet. At that time, 19 % of the lakes were less than 3 feet deep and 3% was over 20 feet deep.

A "hydrologic budget" is an accounting of the inflow to, outflow from and storage in a hydrological unit (such as a lake). "Residence time" is the average length of time particular water stays within a lake before leaving it. This can range from several days to years, depending on the type of lake, amount of rainfall, and other factors. "Flushing rate" is the time it takes a lake's volume to be replaced. "Annual runoff volume", as used in WiLMS, is the total water yield from the drainage area reaching the lake. The "drainage area" is the amount of area (in acres) contributing surface water runoff and nutrients to the lake. The "areal water load" is the total annual flow volume reaching the lake divided by the surface area of the lake. "Hydraulic loading" is the total annual volume of all water sources (including precipitation, non-point sources & point sources) loading into the lake.

Using the data gathered from historical testing and that done by the Adams County LWCD from 2004-2006, the WiLMS model calculated the tributary drainage area for the two Camelot Lakes as 50,333.6 acres. The average unit runoff for Adams County in this area is 9.4 inches. WiLMS determined the expected annual runoff volume as 39,428 acre-feet/year. Anticipated annual hydraulic loading is 39,524.4 acre-feet/year. Areal water load is 88.8 feet/year. In an impoundment lake like these two lakes, a significant portion of the water and its nutrient load running through it from the impounded creek tend to flush through the lake and continue downstream—in Camelot Lake's case, modeling estimates a water residence of 0.11 year. The calculated lake flushing rate is 9.42 1/year. Water and its load flow through these two lakes fairly quickly.

Figure 35: Example of Hydrologic Budget

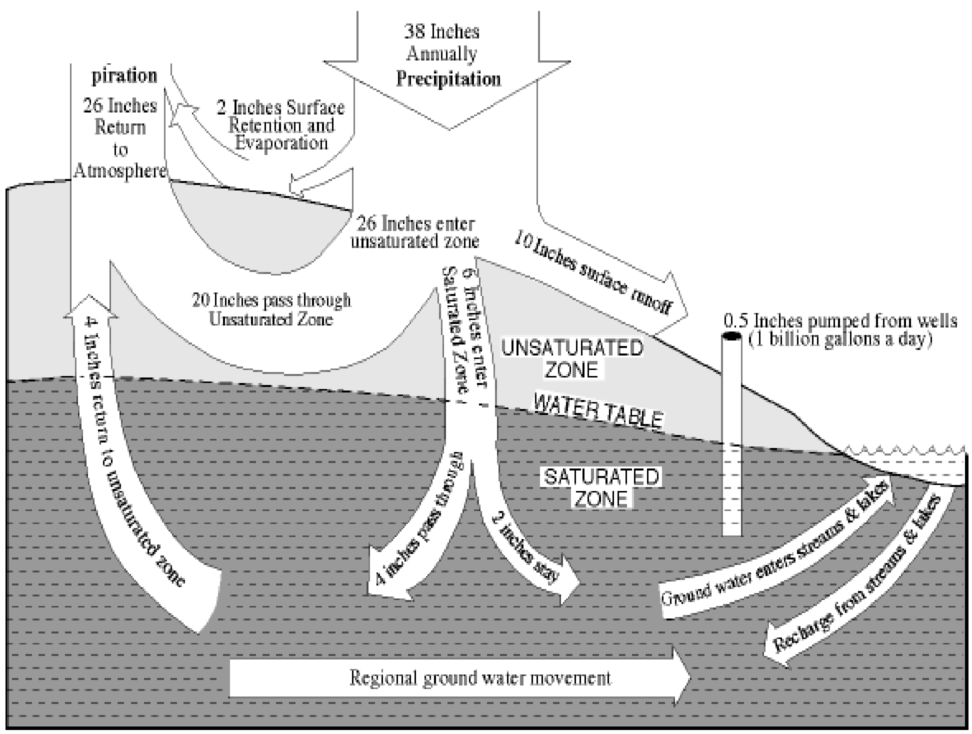
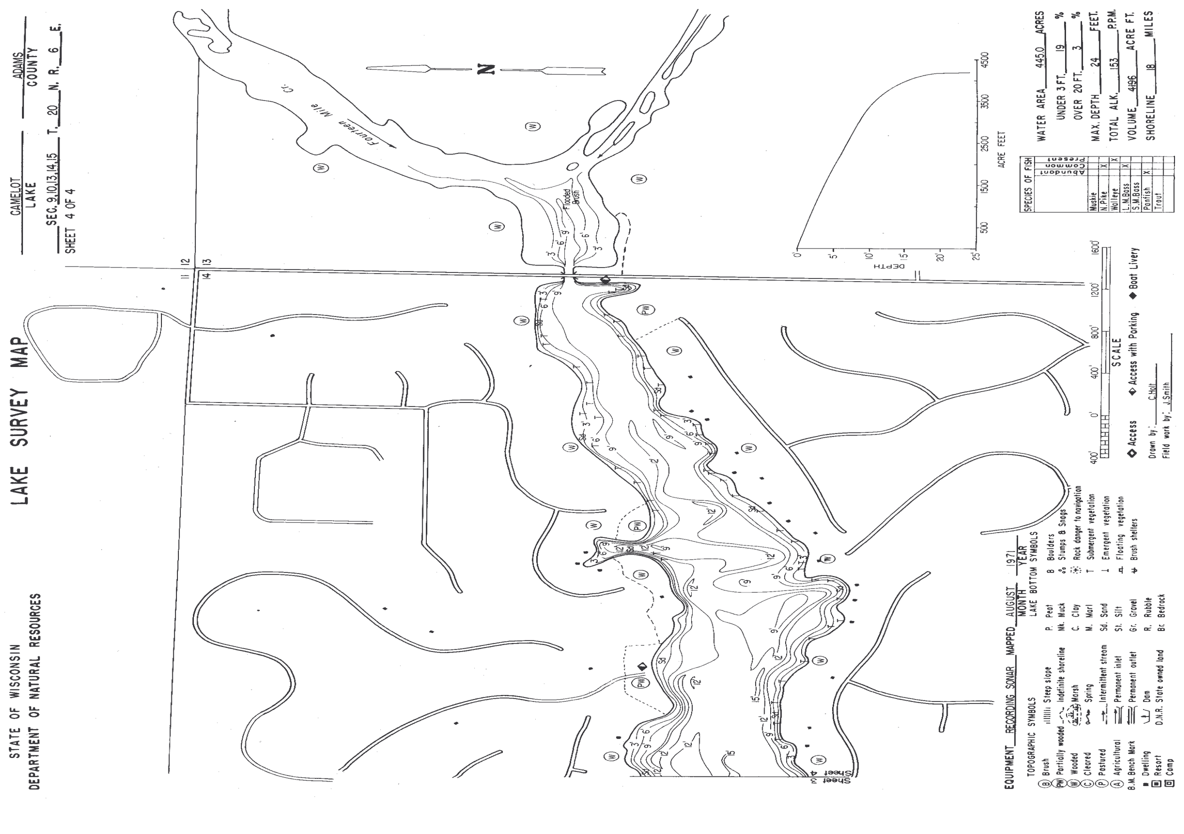


Figure 36a: Lower Camelot Lake Bathymetric Map



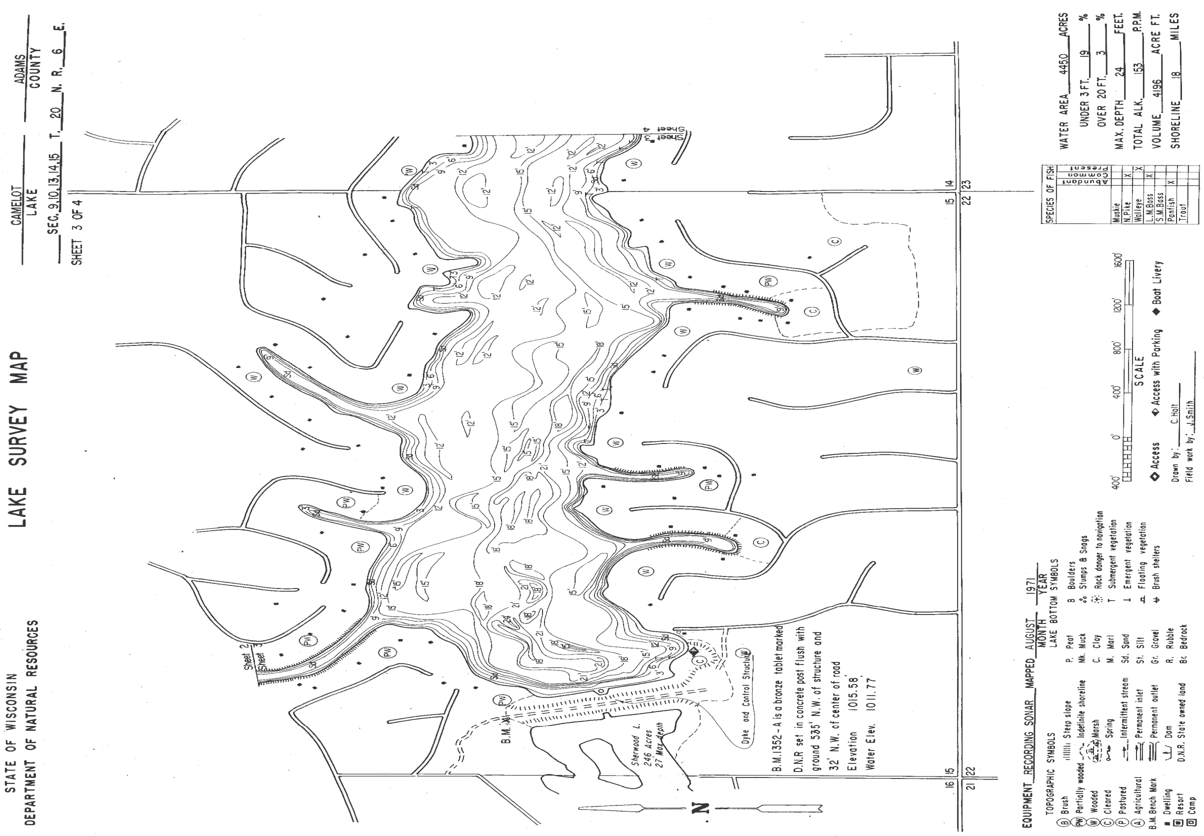
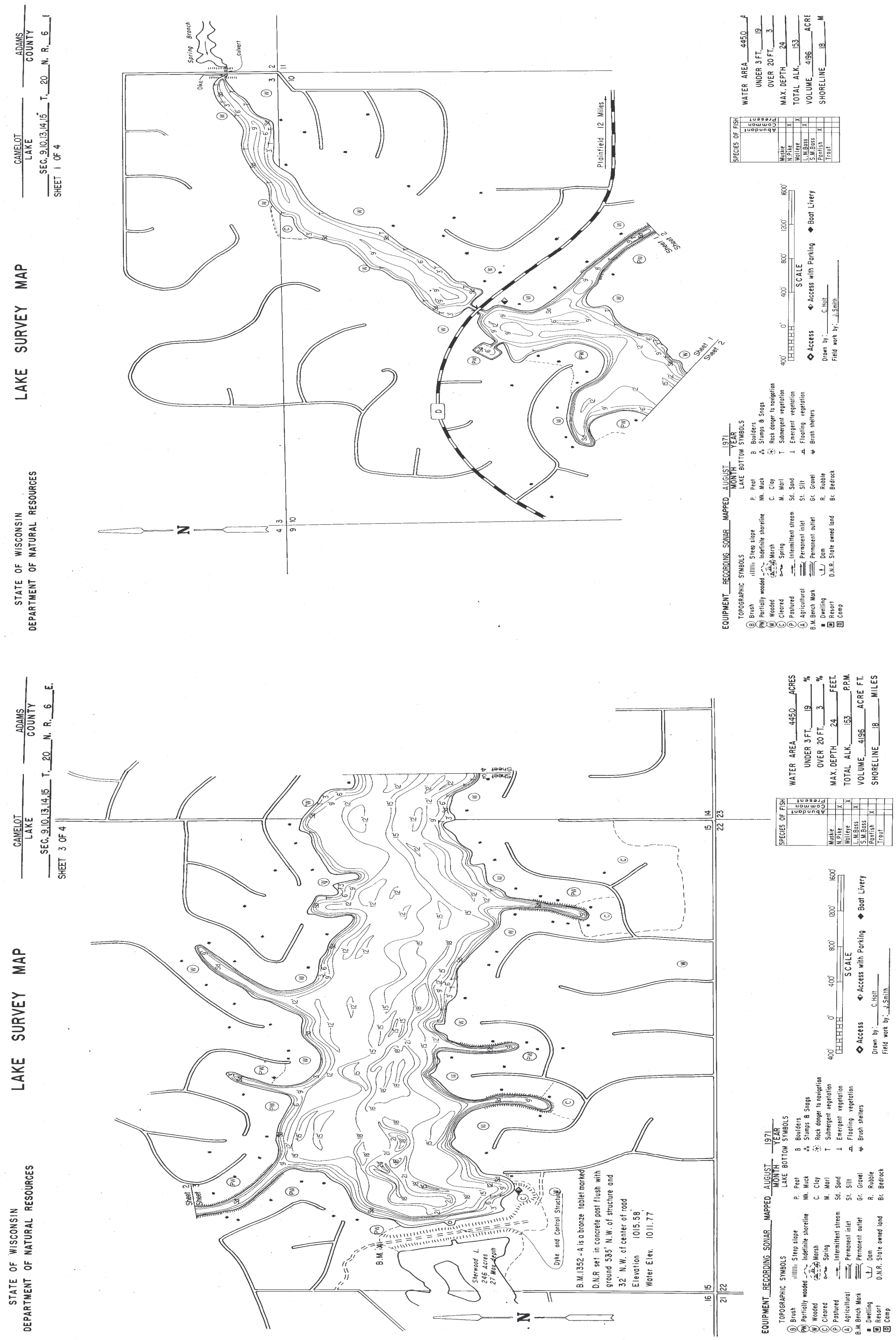


Figure 36b: Upper Camelot Bathymetric Map



TROPHIC STATE

The trophic state of a lake is one measure of water quality, basically defining the lake's biological production status (see Figure 37). **Eutrophic lakes** are very productive, with high nutrient levels, frequent algal blooms and/or abundant aquatic plant growth. **Oligotrophic lakes** are those low in nutrients with limited plant growth and small populations of fish. **Mesotrophic lakes** are those in between, i.e., those which have increased production over oligotrophic lakes, but less than eutrophic lakes; those with more biomass than oligotrophic lakes, but less than eutrophic lakes; often with a more varied fishery than either the eutrophic or oligotrophic lakes. Based on figures from 2004-2006, the Trophic State of Lower Camelot Lake is 53 and for Upper Camelot Lake is 52. This score places both Camelot Lakes' overall TSI at about average for impoundment lakes in Adams County (52.83).

Figure 37: Trophic Status Table

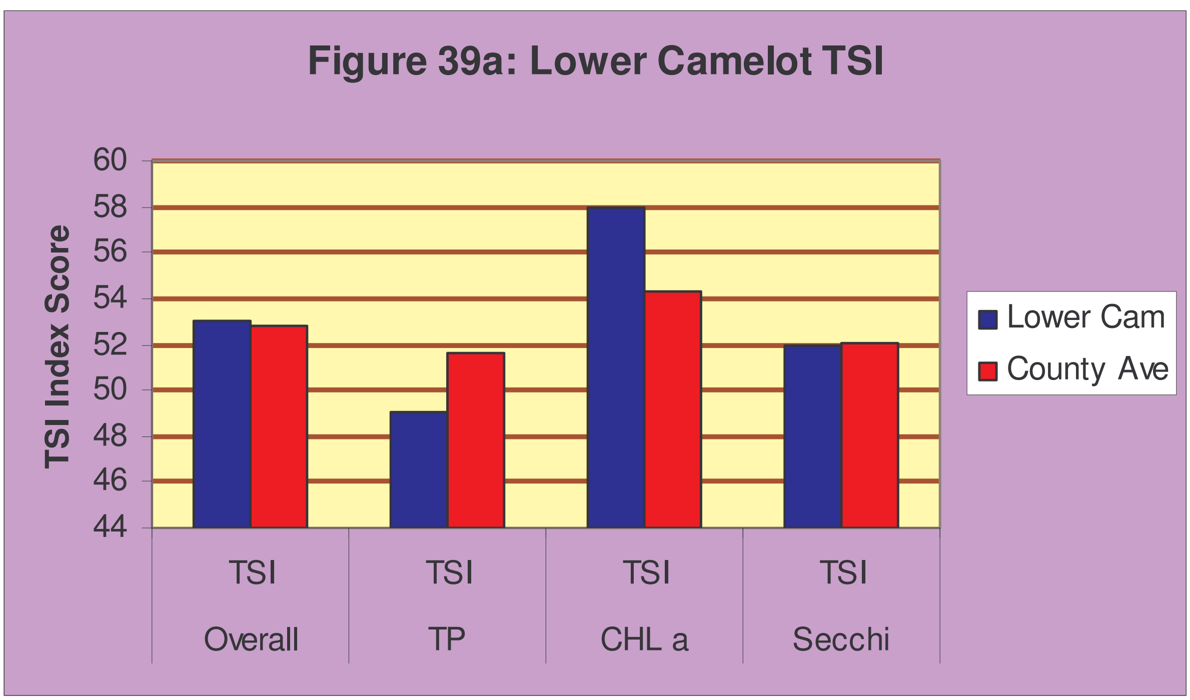
Score	TSI Level Description
30-40	**Oligotrophic:** clear, deep water; possible oxygen depletion in lower depths; few aquatic plants or algal blooms; low in nutrients; large game fish usual fishery
40-50	**Mesotrophic:** moderately clear water; mixed fishery, esp. panfish; moderate aquatic plant growth and occasional algal blooms; may have low oxygen levels near bottom in summer
50-60	**Mildly Eutrophic:** decreased water clarity; anoxic near bottom; may have heavy algal bloom and plant growth; high in nutrients; shallow eutrophic lakes may have winterkill of fish; rough fish common
60-70	**Eutrophic:** dominated by blue-green algae; algae scums common; prolific aquatic plant growth; high nutrient levels; rough fish common; susceptible to oxygen depletion and winter fishkill
70-80	**Hypereutrophic:** heavy algal blooms through most of summer; dense aquatic plant growth; poor water clarity; high nutrient levels

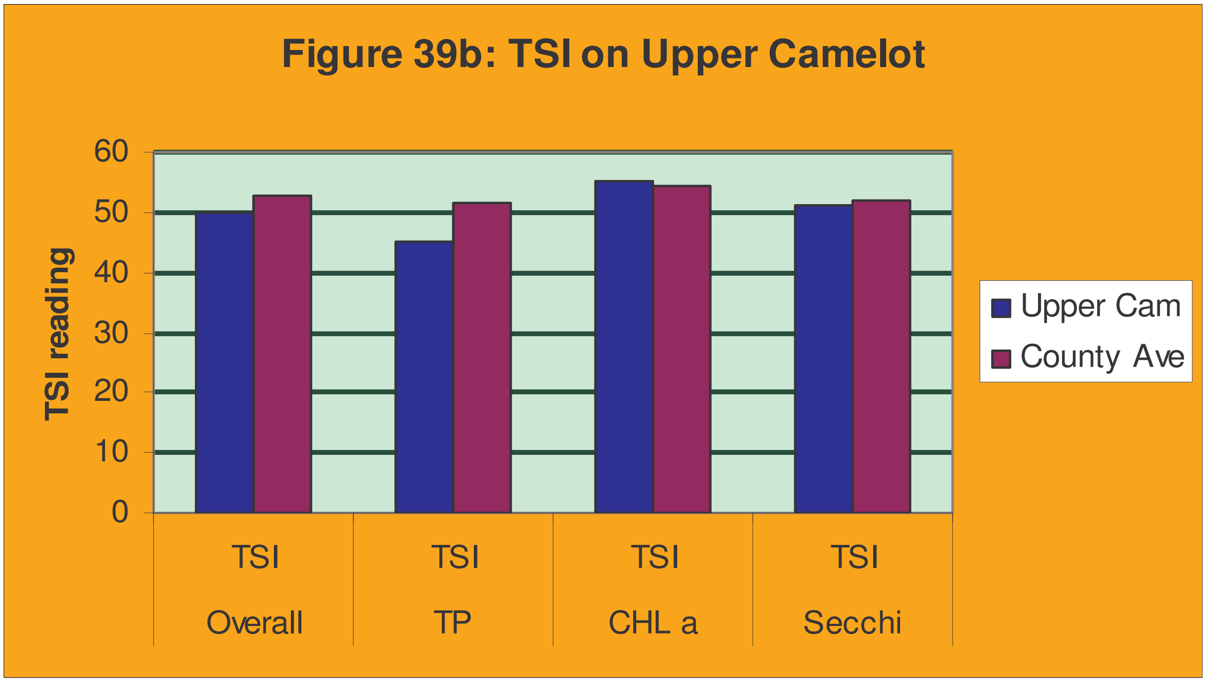
Phosphorus concentration, chlorophyll-a concentration and water clarity data are collected and combined to determine a trophic state. Figure 38 shows where each of these measurements from the two Camelot Lakes fall in trophic level.

Figure 38: Camelot Lakes Trophic Status Overview

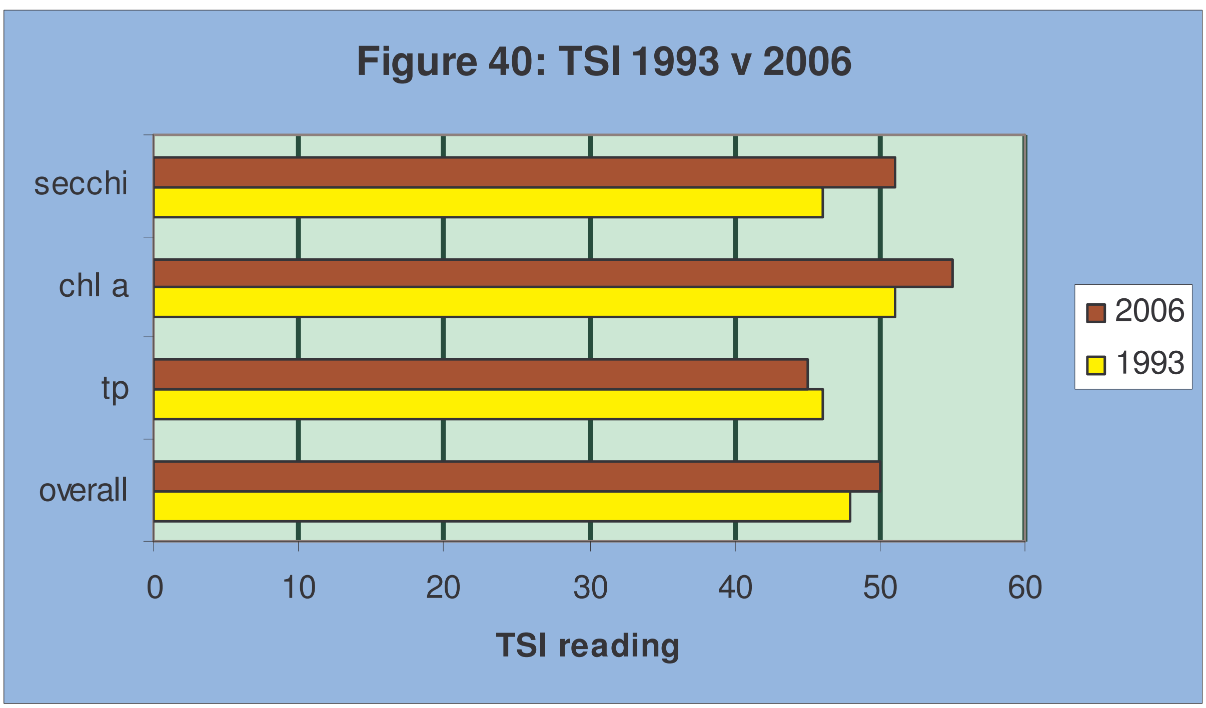
Trophic State	Quality Index	Phosphorus	Chlorophyll a	Sechhi Disk
		(ug/l)	(ug/l)	(ft)
Oligotrophic	Excellent	<1	<1	>19
	Very Good	1 to 10	1 to 5	8 to 19
Mesotrophic	Good	10 to 30	5 to 10	6 to 8
	Fair	30 to 50	10 to 15	5 to 6
Eutrophic	Poor	50 to 150	15 to 30	3 to 4
Lower Camelot		**23.17**	**15.53**	**5.54**
Upper Camelot		**16.92**	**11.9**	**6.19**

These figures show that Lower Camelot Lake has poor to good levels overall for the three parameters often used to describe water quality: Secchi disk depths; average TP for the growing season; and chlorophyll a levels. Upper Camelot Lake is fair to good levels. It is normal for all of these values to fluctuate during a growing season. However, they can be affected by human use of the lake, by summer temperature variations, by algae growth & turbidity, and by rain or wind events.





During the 1993 study, water chemistry samples were taken and TSI levels were calculated. Figure 40, which compares the current TSI levels to those from 1993, shows that two of the three parameters for TSI calculations have increased, indicating that the lake nutrient levels have increased.



IN-LAKE HABITAT

Aquatic Plants

A healthy aquatic plant community plays a vital role within the lake community. This is due to the role plants play in improving water quality, providing valuable habitat resources for fish and wildlife, resisting invasions of non-native species and checking excessive growth of the most tolerant species.

LOWER CAMELOT LAKE

An aquatic plant survey was performed in 2006 by staff from the Adams County Land & Water Conservation Department and a Tri-Lakes property owner. The Simpson's Diversity Index in 2006 for Lower Camelot Lake was .87, showing fair species diversity. This was lower from the 2000 index of .91. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places it in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. The AMCI for Lower Camelot Lake is 53, placing it in the average range for North Central Wisconsin Lakes and all Wisconsin Lakes. The AMCI in 2000 was also 53. In 2000, there were fewer species and fewer sensitive plants, but more submergent plants.

Natural vegetation covered only 23.0% of the lake shoreline. Naturally-occurring rock covered 2.5% of the shore. Disturbed shorelines—including bare sand, traditional cultivated lawn, hard structure (piers, decks, seawalls, etc.) and rock riprap--were the most frequently-occurring shore, with each occurring with 25% to 70% frequency. Overall, they covered 77.0% of the shore of Lower Camelot Lake.

Of the 23 species found in Lower Camelot Lake, 21 were native and 2 were exotic invasives. In the native plant category, 8 were emergent, 1 was a floating-leaf plant, and 12 were submergent species. Two exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Phalaris arundinacea* (Reed Canarygrass) were found. Filamentous algae were found at 8.22% of the sample sites in 2006 and at 16.44% of the sites in 2000.

Comparing the species found in 2006 to those reported in 2000, some changes are evident. Plants found in 2000 that were not found in 2006 included: *Eleocharis acicularis* (emergent); *Lemna minor* (free-floating); and *Potamogeton crispus* (an invasive submergent). Several plants found in 2006 were not found in 2000: *Alisma gramineum* (emergent); *Carex* spp (emergent); *Impatiens capensis* (emergent); *Myriophyllum sibiricum* (submergent); *Potamogeton zosteriformis* (submergent); and

Salix spp (emergent). Since the 2006 plant survey was conducted in August, past primary growing season for *Potamogeton crispus*, it is possible that *P. crispus* was present earlier in the summer in 2006, since it was found in 2000.

Figure 41: Aquatic Plants in Lower Camelot Lake

Scientific Name	Common Name	Type	Found in 2000
Alisma gramineus	Water Plantain	Emergent	
Carex spp	Sedge	Emergent	
Ceratophyllum demersum	Coontail	Submergent	x
Chara spp	Muskgrass	Submergent	x
Elodea canadensis	Waterweed	Submergent	x
Impatiens capensis	Jewelweed	Emergent	
Leersia oryzoides	Rice Cut-grass	Emergent	
Myriophyllum sibiricum	Northern Milfoil	Submergent	
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent	x
Najas flexilis	Bushy Pondweed	Submergent	x
Phalaris arundinacea	Reed Canarygrass	Emergent	x
Polygonum amphibium	Water Smartweed	Floating Leaf	
Potamogeton foliosus	Leafy Pondweed	Submergent	x
Potamogeton illinoensis	Illinois Pondweed	Submergent	
Potamogeton pectinatus	Sage Pondweed	Submergent	x
Potamogeton pusillus	Small Pondweed	Submergent	x
Potamogeton zosteriformis	Flat-Stem Pondweed	Submergent	
Sagittaria latifolia	Lower Camelot	Emergent	x
Salix spp	Willow	Emergent	
Scirpus validus	Soft-Stem Bulrush	Emergent	x
Typha angustifolia	Narrow-Leaf Cattail	Emergent	x
Vallisneria americana	Water Celery	Submergent	x
Zosterella dubia	Water Stargrass	Submergent	x

Of the plants on this list, several are species likely to increase in frequency and/or density in the case of regular drawdowns: *Leersia oryzoides* (emergent); *Najas flexilis* (submergent); *Potamogeton crispus* (submergent exotic); *Potamogeton pectinatus* (submergent); *Scirpus validus* (emergent) and *Potamogeton zosteriformis* (submergent). Some also tend to decrease with regular drawdowns: *Chara* spp (submergent); *Myriophyllum sibiricum* (submergent); *Myriophyllum spicatum* (submergent exotic); and *Vallisneria americana* (submergent). In general, regular drawdowns will tend to encourage the increase of plants that can survive frequent disturbances and will also tend to reduce the diversity of the aquatic plant community.

Najas flexilis and *Vallisneria americana* were the most frequently-occurring plants in Lower Camelot Lake in 2006 (each with 46.58% frequency), closely followed by *Chara* spp at 42.47% occurrence frequency. In 2000, *Chara* spp. was the most-frequency occurring species. No species reached a frequency of 50% or greater in the lake overall in either 2000 or 2006. When reviewing the frequency where vegetated in 2006, only *Vallisneria americana* reached an occurrence frequency over 50%, and *Chara* spp was just under at 49.21%. The only species reaching an occurrence frequency over 50% where present in 2000 was *Chara* spp at 50.79%. Overall, the occurrence of *Chara* has not changed since 2000, but both *Najas flexilis* and *Vallisneria americana*, both plants that are very tolerant of disturbance, have increased dramatically since 2000. *Vallisneria americana* is also encouraged by harvesting.

Vallisneria americana was also the densest plant in 2006 in Lower Camelot Lake, with a mean density of 1.36 (on a scale of 1 to 4). In the lake overall, none of the aquatic vegetation had a mean density of over 2.0, meaning none occurred at more than average density, in either 2000 or in 2006. However, when looking at the "mean density where presen", several plants had a more than average density in 2006: *Najas flexilis; Potamogeton illinoensis; Potamogeton zosteriformis,* and *Vallisneria americana.* All of these plants are submergent plants. These figures indicate several species in the lake have higher than average growth form density that can interfere with fish habitat and recreational use.

In 2000, more species occurred at more than average "density where present" than in 2006: *Ceratophyllum demersum; Chara spp; Eleocharis acicularis; Najas flexilis; Potamogeton pectinatus; Potamogeton pusillus; Typha angustifolia;* and *Vallisneria americana.* Only *Eleocharis acicularis* and *Typha angustifolia* are emergent plants; the rest are submergent plants.

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Vallisneria americana* was the dominant aquatic "plant" species in Lower Camelot Lake in 2006, followed closely by *Najas flexilis*. Sub-dominant were *Chara* spp. *Chara* spp dominated the aquatic plant community of Lower Camelot Lake in 2000. The next closest species was *Ceratophyllum demersum*, with half the dominance value of *Chara spp* in 2000.

Myriophyllum spicatum and *Phalaris arundinacea*, the exotics found Lower Camelot Lake, were not present in high frequency or high density, but *Myriophyllum spicatum* had substantial dominance in both years.

Species richness increased slightly between 2000 and 2006, with the biggest increase in richness found in Depth Zone 1 (0-1.5').

Figure 42: Lower Camelot Lake Species Richness Table

	2006	2000
Zone 1	3.19	2.42
Zone 2	2.3	2.6
Zone 3	3	3.57
Zone 4	1.5	2.08
Overall	2.86	2.73

Using the AMCI index, no significant overall change has occurred in the aquatic plant community in Lower Camelot Lake between 2000 and 2006.

Figure 43: AMCI Table For Lower Camelot Lake

	2000 Result	2000 Value	2006 Result	2006 Value
Maximum Rooting Depth	13'	7	15.5'	9
% Littoral Zone Vegetated	86.30%	10	86.30%	10
% Submergent Species	82%	10	95%	7
% Sensitive Species	3%	4	11%	6
% Exotic Species	10%	5	10%	5
Taxa #	18	8	23	9
Simpson's Diversity Index	0.91	9	0.87	7
		53		53

The presence of several invasive, exotic species could be a significant factor in the future. Currently, none of the exotic species appear to be taking over the aquatic plant community, but *Myriophyllum spicatum* had an occurrence frequency over 24% and increased since 2000, despite the long history of both chemical and mechanical control efforts. This plant must continue to be monitored, since its tenacity and ability to spread to large areas fairly quickly could make them a danger to the diversity of Lower Camelot Lake's current aquatic plant community. Although no *Potamogeton crispus* was found in Lower Camelot Lake in 2006, it was found in the 2000 survey. Since the 2006 survey was conducted in August, it is possible that this lake still has *Potamogeton crispus* that had simply died off by then, since *P. crispus* tends to be an early-season plant. The lake should also be monitored for this invasive.

The Average Coefficient of Conservatism in Lower Camelot Lake in 2006 was 4.4 and 3.69 in 2000. This puts this lake in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in Lower Camelot Lake is in the category of those lakes most tolerant of disturbance, probably due to selection by a series of past disturbances.

The Floristic Quality Index of the aquatic plant community in Lower Camelot Lake of 19.68 in 2006 and 16.5 in 2000 is below average for Wisconsin Lakes (average 22.2) and the North Central Hardwood Region (average 20.9). This suggests that the plant community in Lower Camelot Lake is farther from an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. However, the Floristic Quality Index has increased between 2000 and 2006, suggesting some small progress in overall aquatic plant health may be occurring. Using either the Average Coefficient of Conservatism or the Floristic Quality Index scales, the aquatic plant community in Lower Camelot Lake apparently has been impacted by a more than average amount of disturbance.

Mechanical harvesting of aquatic plants in Lower Camelot Lake started in 1995 and has continued through 2006. The chart below shows the pounds of aquatic plant removed through mechanical harvesting through 2006. For 2005 and 2006, plant samples were taken to a laboratory to be tested for the amount of phosphorus in milligrams per kilogram of aquatic plants. This is also shown on the chart below.

Figure 44: Mechanical Harvesting Results in Lower Camelot Lake

Year	Lake Camelot (lbs)	Lower Camelot (lbs)	Phosphorus Removed (lbs)
1995	153,000		NA
1996	139,600		NA
1997	152,000		NA
1998	292,000		NA
1999		307,600	NA
2000		276,000	NA
2001		376,600	NA
2002		453,000	NA
2003		453,000	NA
2004		338,000	NA
2005		911,400	2413.39
2006		607,000	871.65
total	736,600	3,722,600	3,285

Earlier efforts tended to be centered about application of chemical for aquatic plant control. Both copper in pounds and cutrine in gallons added copper to Lower Camelot Lake. Copper is an element and does not degrade any further. Copper is known to harm native mollusks (clams, mussels, snails) and invertebrates that serve as food for the fish. Hydrothol, added to Lower Camelot Lake between 1977 and 1984, has been implicated in damage to young fish.

Figure 45: Chemical Aquatic Plant Control In Lower Camelot Lake

Year	Copper	Cutrine+	Aquathol	Hydrothol	Diquat	Rodeo	2,4-D	Silvex	AV-70
-	(lbs)	(gal)	(gal)	(gal)	(gal)	(gal)	(lbs)	-	-
1970	400		5		10			2	
1971	85		5		29.5			13	
1972	105				8				
1973	985				29.5				
1974	380				23				
1975	374		16.5		13				14
1976	130		70	100	16				17
1977	520		25	400	10		14		10.5
1978									
1979	400								
1980	250								
1984				30					
1985	75		26		5				
1986	265		24		4				
1987	210								
1988	1085				20				
1989	1000		15		10				
1990	270		15		21	6	10		
1991	375		12.5		4		10		
1992	350		20		12				
1993	200				15		10		
1994	150		38.25		22.75		10		
1995	355		52		21.75		10		
1996		32	15		15		10		
1997		46.5	3		3				
1999			5		5				
2000					30				
total	**7967**	**78.5**	**362.25**	**530**	**327.5**	**6**	**74**	**19**	**41.5**

Looking at the results from the 2000 survey and those from 2006 shows some changes in the aquatic plant community, not necessarily for the better. Although there were slightly more species found in 2006, the structure of the aquatic plant community has become more unbalanced, shifting to even more submergent vegetation, with fewer emergent, floating-leaf and free floating aquatic plants. Although species richness, the Floristic Quality Index, the Average Coefficient of Conservatism, and the AMCI has stayed close in value, these values are still below or barely at average.

Figure 46: Changes in the Aquatic Plant Community 2000 to 2006 Lower Camelot Lake

Lower Camelot	2000	2006	Change	%Change
Number of Species	18	23	2	**27.8%**
Maximum Rooting Depth in Feet	13.0	15.5	3	**19.2%**
% of Littoral Zone Unvegetated	13.7%	13.7%	0.0%	0.0%
%Sites/Emergents	11.63%	4.44%	-0.1	-61.8%
%Sites/Free-floating	6.50%	0.00%	-0.1	-100.0%
%Sites/Submergents	81.97%	95.58%	0.1	16.6%
%Sites/Floating-leaf	9.00%	1.00%	-0.1	-88.9%
Simpson's Diversity Index	0.91	0.87	-0.04	-4.4%
Species Richness	2.73	2.86	0.13	**4.8%**
Floristic Quality	16.50	19.68	3.18	**19.3%**
Average Coefficient of Conservatism	3.89	4.4	0.51	**13.1%**
AMCI Index	53	53	0	0%

Further, when calculating the Coefficient of Similarity between the 2000 and 2006 surveys, they score as statistically dissimilar. Based on frequency of occurrence and relative frequency, the aquatic plant communities of the two years are only 65% similar. Similarity percentages of 75% or more are considered statistically similar; obviously, Lower Camelot Lake percentages are far from that. It is worth noting that the report on the 2000 aquatic plant surveys mentioned the absence of emergent plants in Lower Camelot Lake. The 2006 survey shows that emergent plants are even scarcer in Lower Camelot Lake than they were in 2000. *Vallisneria americana*, which is encouraged by harvesting, has increased in frequency and density two to three fold. *Najas flexilis*, a disturbance indicator, has more than doubled.

Figure 47a: Emergent Plants in Lower Camelot Lake 2006

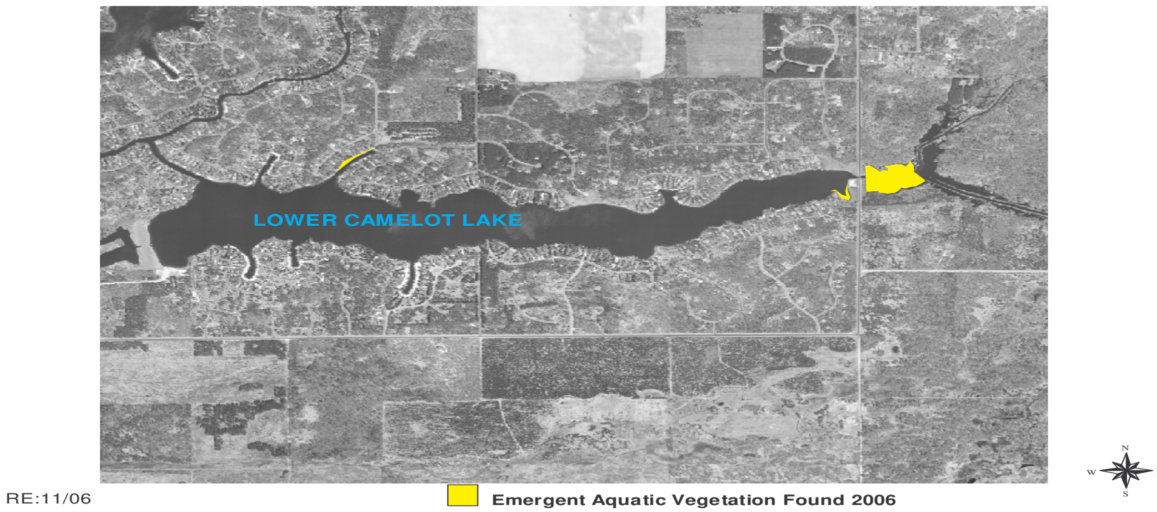
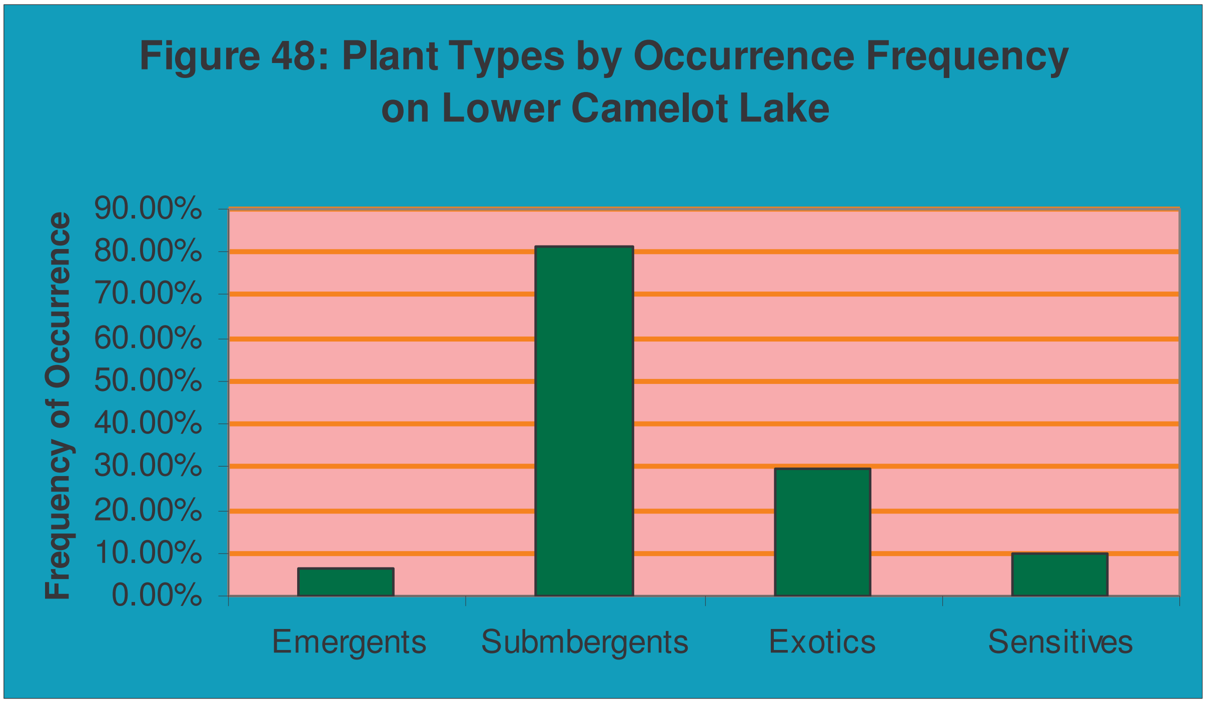


Figure 47b: Submerged Plants in Lower Camelot Lake 2006



UPPER CAMELOT

An updated aquatic macrophytes (plants) field study of Upper Camelot Lake was conducted during August 2006 by a staff member the Adams County Land and Water Conservatism Department and a staff member of the Tri-Lakes Management District. The first quantitative vegetation study was performed by Wisconsin Department of Natural Resources staff in 2000.

Some type of natural vegetated shoreline covered only 26.25% of the lake shoreline in 2006. Disturbed shorelines—including bare sand, traditional cultivated lawn, hard structure (piers, decks, seawalls, etc.) and rock riprap--were the most frequently-occurring shore, covering 73.75% of the shore of Upper Camelot Lake. Cultivated lawn had the highest coverage—nearly one half the shoreline.

In the past two years, a concerted effort has been made on Camelot Lake to install shore protection and/or restoration practices. Perhaps this is the reason why cultivated lawn and eroded bare shore had slightly less coverage in 2006 than in 2000 (44% vs. 55%) and why there was slightly more vegetated shore coverage in 2006 than in 2000 (26.25% vs. 21.25%). However, the amount of coverage by rock riprap and hard structure increased since 2000.

Of the 29 species found in Upper Camelot Lake, 27 were native and 2 were exotic invasives. In the native plant category, 9 were emergent, 1 was a floating-leaf plant, 1 was free-floating and 16 were submergent species. Two exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed) were found. Filamentous algae were found at 8.22% of the sample sites in 2006 and at 29.51% of the sites in 2000.

Comparing the species found in 2006 to those reported in 2000, some changes are evident. Only one plant was found in 2000 that was not found in 2006 included: *Lemna minor* (free-floating). Several plants found in 2006 were not found in 2000: *Eleocharis smallii* (emergent); *Myriophyllum heterophyllum* (submergent); *Myriophyllum sibiricum* (submergent); *Potamogeton gramineus* (submergent); *Potamogeton illinoensis* (submergent); *Potamogeton natans* (submergent); *Sagittaria latifolia* (emergent); *Salix spp* (emergent); *Scirpus validus* (emergent); and *Typha angustifolia* (emergent). Since the 2006 plant survey was conducted in August, past primary growing season for *Potamogeton crispus*, it is possible that *P. crispus* was present in greater occurrence earlier in the summer in 2006, since it was found in 2000.

Of the plants on the species list, several are likely to increase in frequency and/or density if there are regular drawdowns: *Carex* spp (emergent); *Najas flexilis* (submergent); *Potamogeton crispus* (submergent exotic); *Potamogeton pectinatus* (submergent); *Potamogeton zosteriformis* (submergent); and *Salix* spp (emergent). Some of the plants on this list tend to decrease with drawdowns: *Chara* spp (submergent); *Myriophyllum sibiricum* (submergent); *Myriophyllum spicatum* (submergent exotic); and *Vallisneria americana* (submergent). In general, regular drawdowns will tend to encourage the plants that can handle frequent disturbances and will also tend to reduce the diversity of the aquatic plant community.

Chara spp was the most frequently-occurring "plant" in Upper Camelot Lake in 2006, as it was in 2000. No species but *Chara* spp reached a frequency of 50% or greater in the lake overall in either 2000 or 2006. When reviewing the occurrence frequency within vegetated areas in 2006, only *Chara* spp reached an occurrence frequency over 50%; next closest was *Najas flexilis* at 36.62% occurrence within vegetated beds. The same pattern was followed in 2000, with *Najas flexilis* occurring at 45.90% where present.

Chara spp was also the densest plant in 2006 in Upper Camelot Lake, with a mean density of 1.92 (on a scale of 1 to 4). In the lake overall, none of the aquatic vegetation had a mean density of over 2.0, meaning none occurred at more than average, in 2006.

Figure 49: Aquatic Plants on Upper Camelot Lake 2006

Scientific Name	Common Name	Type	in 2000
Carex spp	Sedge	Emergent	
Cerataphyllum demersum	Coontail	Submergent	x
Chara spp	Muskgrass	Submergent	x
Elodea canadensis	Waterweed	Submergent	x
Eleocharis acicularis	Needle Spikerush	Emergent	x
Eleocharis smallii	Marsh Spikerush	Emergent	
Impatiens capensis	Jewelweed	Emergent	
Myriophyllum heterophyllum	Various-Leafed Watermilfoil	Submergent	
Myriophyllum sibiricum	Northern Milfoil	Submergent	
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent	x
Najas flexilis	Bushy Pondweed	Submergent	x
Polygonum amphibium	Water Smartweed	Floating-Leaf	x
Potamogeton amplifolius	Large-Leaf Pondweed	Submergent	x
Potamogeton crispus	Curly-Leaf Pondweed	Submergent	x
Potamogeton foliosus	Leafy Pondweed	Submergent	x
Potamogeton gramineus	Variable Pondweed	Submergent	
Potamogeton illioensis	Illinois Pondweed	Submergent	
Potamogeton natans	Floating-Leaf Pondweed	Submergent	
Potamogeton nodusus	Long-Leaf Pondweed	Submergent	x
Potamogeton pectinatus	Sago Pondweed	Submergent	x
Potamogeton pusillus	Small Pondweed	Submergent	x
Potamogeton zosteriformis	Flat-Stem Pondweed	Submergent	x
Sagittaria latifolia	Arrowhead	Emergent	
Salix spp	Willow	Emergent	
Schoenoplectus pungens	Common Threesquare	Emergent	
Scirpus validus	Soft-Stem Bulrush	Emergent	
Vallisneria americana	Water Celery	Submergent	
Wolffia columbiana	Watermeal	Free-Floating	x
Zosterella dubia	Water Stargrass	Submergent	x

However, when looking at the "mean density where present", seven plants in addition to *Chara* spp had a more than average density of occurrence in 2006: *Najas flexilis; Potamogeton amplifolius; Potamogeton gramineus, Potamogeton pectinatus, Potamogeton zosteriformis, Scirpus validus,* and *Vallisneria americana.* Except for *Scirpus validus,* all of these plants are submergent plants. These figures indicate several species of the lake have higher than average growth form density that can interfere with fish habitat and recreational use.

In 2000, more species occurred at higher than average "density where present" than in 2006. In 2000, there eleven plants in addition to *Chara* spp in 2000 that had more than average density where present: *Ceratophyllum demersum; Elodea canadensis; Myriophyllum spicatum; Najas flexilis; Potamogeton amphibium; Potamogeton foliosus; Potamogeton nodosus; Potamogeton pectinatus; Scirpus palustris; Typha angustifolia;* and *Zosterella dubia.* Nine of these are submergent plants.

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Chara* spp was the dominant aquatic "plant" species in Upper Camelot Lake in 2006, followed by *Najas flexilis*. *Chara* spp dominated the aquatic plant community of Upper Camelot Lake in 2000, with *Najas flexilis* coming in second. *Myriophyllum spicatum* and *Phalaris arundinacea*, the exotics found Upper Camelot Lake, were not present in high frequency, high density or high dominance in either year, although *Myriophyllum spicatum* had a greater presence in 2000.

Species richness increased slightly between 2000 and 2006, with the biggest increase in richness found in Depth Zone 1 (0-1.5').

Figure 50: Species Richness in Upper Camelot Lake

	2006	2000
Zone 1	4.58	3.47
Zone 2	3.4	2.78
Zone 3	4.5	3.7
Zone 4	2.36	2.5
Overall	3.87	3.21

The Simpson's Diversity Index for Upper Camelot Lake in 2006 was .93, a good species diversity. A rating of 1.0 would mean that each plant in the lake was a different species (the most diversity achievable). This places it in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest and all Wisconsin lakes. This is considerably higher than the Simpson's Diversity Index for 2000, which was .88. The 2006 AMCI for Upper Camelot Lake is 58, placing it just above the average range for North Central Wisconsin Lakes and all Wisconsin Lakes. The AMCI value for 2000, .52, is in the average range.

Figure 51: Upper Camelot AMCI Comparison

AMCI Category	2000 Result	2000 Value	2006 Result	2006 Value
Max. Rooting Depth	13'	7	13'	7
% Littoral Zone Veg.	89.7%	10	97.2%	10
% Submersed Species	91%	8	81%	10
% Exotic Species	13%	4	7%	5
% Sensitive Species	15%	7	10%	6
Taxa #	18	8	30	10
Simpson's Index	0.88	8	0.93	10
		52		58

The presence of two invasive, exotic species could be a significant factor in the future. Currently, none of the exotic species appear to be taking over the aquatic plant community, but *Myriophyllum spicatum* had an occurrence frequency of nearly 24% in 2006, despite the long history of both chemical and mechanical control efforts. This plant must continue to be monitored, since its tenacity and ability to spread to large areas fairly quickly could make it a danger to the diversity of Upper Camelot Lake's current aquatic plant community. Although some *Potamogeton crispus* was found in Upper Camelot Lake in 2006, it was not at a high frequency or density. Since the 2006 survey was conducted in August, it is possible that this lake had more *Potamogeton crispus* that had simply died off earlier in the summer, since *P. crispus* tends to be an early-season plant. The lake should also be monitored for this invasive.

The Average Coefficient of Conservatism in Upper Camelot Lake in 2006 was 4.63, down very slightly from 4.68 in 2000. This puts this lake in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in Upper Camelot Lake is in the category of those lakes most tolerant of disturbance, probably due to selection by a series of past disturbances.

The Floristic Quality Index of the aquatic plant community in Upper Camelot Lake of 25.38 in 2006 is above average for Wisconsin Lakes (average 22.2) and the North Central Hardwood Region (average 20.9). This suggests that the plant community in Upper Camelot Lake is farther from an undisturbed condition than the average lake in Wisconsin overall and in the North Central Hardwood Region. The 2000 figure of 20.42 was slightly below average. The Floristic Quality Index has increased between 2000 and 2006, suggesting some small progress in overall aquatic plant health may be occurring. Using either the Average Coefficient of Conservatism or the Floristic

Quality Index scales, the aquatic plant community in Upper Camelot Lake apparently has been impacted by a more than average amount of disturbance.

The lake has some mixture of structure of emergent, free-floating, floating-leaf and submerged plants. Of the 20 species found in Upper Camelot Lake, 27 were native and 2 were exotic invasives. However, emergent and floating-leaf plants are very important for habitat, so the facts that floating-leaf vegetation is very sparse and emergent plants declined in coverage are causes for concern. In the native plant category, 9 were emergent, 1 was a floating-leaf plant, 1 was free-floating and 16 were submergent species. Two exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *Potamogeton crispus* (Curly-Leaf Pondweed) were found.

Chara spp was the most frequently-occurring "plant" in Upper Camelot Lake in 2006, as it was in 2000. No species but *Chara* spp reached a frequency of 50% or greater in the lake overall in either 2000 or 2006. The same pattern was followed in 2000, with *Najas flexilis* occurring at 45.90% where present.

Looking at the results from the 2000 survey and those from 2006 shows some changes in the aquatic plant community. There were more species found in 2006, and the structure of the aquatic plant community has changed with less emergent cover. There is only one species of floating-leaf plants, which provide habitat and cover for fish and invertebrates. Free-floating plants, indicators of nutrient enrichment and poor water clarity, have substantially increased since 2000.

When calculating the coefficient of similarity between the 2000 and 2006 surveys, they score as statistically similar in terms of frequency of occurrence, but dissimilar in terms of relative frequency. Based on frequency of occurrence, the aquatic plant communities of the two years are just over 75% similar. Similarity percentages of 75% or more are considered statistically similar. But using relative frequency, the score is only 68% similar.

Overall, most species have not changed in frequency, but a few species have shifted their standing in the community; for example, *Ceratophyllum demersum* and *Potamogeton pectinatus* have increased, but *Elodea canadensis* and *Potamogeton amplifolius* have increased. It is worth noting that the report on the 2000 aquatic plant surveys mentioned the low level of emergent plants in Upper Camelot Lake. The 2006 survey shows that occurrence and cover of emergent plants are were still scarce in Upper Camelot Lake, scarcer than they were in 2000, but there were more species of emergent plants in 2006. Some valuable pondweeds and water smartweed have increased; *Elodea canadensis*, *Myriophyllum spicatum,* and some sensitive pondweeds have declined substantially. Water clarity may have improved, but disturbance level is still high.

Figure 52: Changes in Upper Camelot Aquatic Plant Community

Upper Camelot	2000	2006	Change	%Change
Number of Species	19	30	11	**57.9%**
Maximum Rooting Depth in Feet	13.0	13.0	0	0.0%
% of Littoral Zone Unvegetated	10.3%	2.8%	-0.075	-72.8%
%Sites/Emergents	6.56%	5.80%	-9.19	-140.09.%
%Sites/Free-floating	1.64%	11.59%	0.29	**1768.3%**
%Sites/Submergents	100.00%	100.00%	-0.09	-9.0%
%Sites/Floating-leaf	0.00%	1.87%	1.82	**364.0%**
Simpson's Diversity Index	0.89	0.93	0.04	**4.5%**
Species Richness	3.21	3.87	0.66	**20.6%**
Floristic Quality	20.42	25.38	4.96	**24.3%**
Average Coefficient of Conservatism	4.68	4.63	-0.05	-1.1%
AMCI Index	52	58	6.00	**11.5%**

Efforts at controlling aquatic plant growth have included both chemical treatments and mechanical harvesting.

Mechanical harvesting of aquatic plants in Upper Camelot Lake started in 1995 and has continued through 2006. The chart below shows the pounds of aquatic plant removed through mechanical harvesting through 2006. For 2005 and 2006, plant samples were taken to a laboratory to be tested for the amount of phosphorus in milligrams per kilogram of aquatic plants. This is also shown on the chart below.

Figure 53: Mechanical & Chemical Aquatic Plant Control

Year	Lake Camelot (lbs)	Upper Camelot (lbs)	Phosphorus Removed (lbs)
1995	153,000		NA
1996	139,600		NA
1997	152,000		NA
1998	292,000		NA
1999		293,000	NA
2000		281,000	NA
2001		247,600	NA
2002		240,200	NA
2003		302,000	NA
2004		466,000	NA
2005		516,400	762.21
2006		784,600	212.21
total	736,600	3,130,800	974.42

Year	Copper (lbs)	Cutrine+ (gal)	Aquathol (gal)	Hydrothol (gal)	Diquat (gal)	Rodeo (gal)	2,4-D (lbs)	Silvex	AV-70
1970	400		5		10			2	
1971	85		5		29.5			13	
1972	105				8				
1973	985				29.5				
1974	380				23				
1975	374		16.5		13				14
1976	130		70	100	16				17
1977	520		25	400	10		14		10.5
1978									
1979	400								
1980	250								
1984				30					
1985	75		26		5				
1986	265		24		4				
1987	210								
1988	1085				20				
1989	1000		15		10				
1990	270		15		21	6	10		
1991	375		12.5		4		10		
1992	350		20		12				
1993	200				15		10		
1994	150		38.25		22.75		10		
1995	355		52		21.75		10		
1996		32	15		15		10		
1997		46.5	3		3				
1999			5		5				
2000					30				
total	**7967**	**78.5**	**362.25**	**530**	**327.5**	**6**	**74**	**19**	**41.5**

Figure 54a: Emergent Aquatic Plant on Upper Camelot Lake 2006

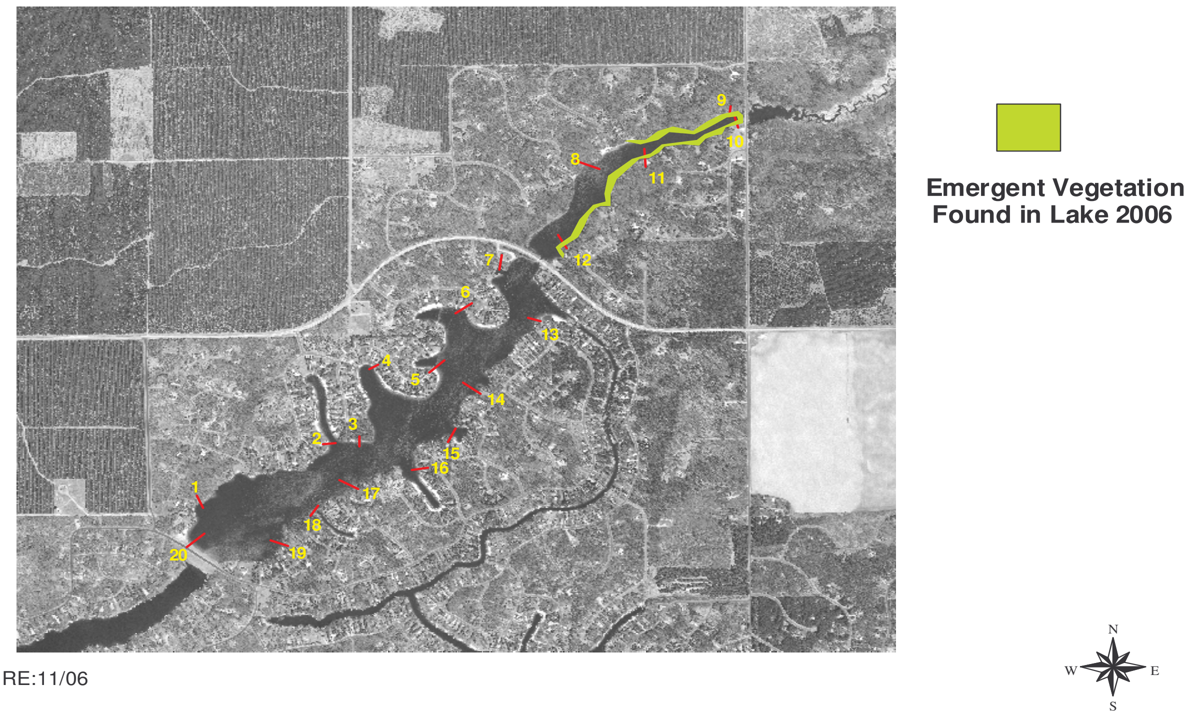
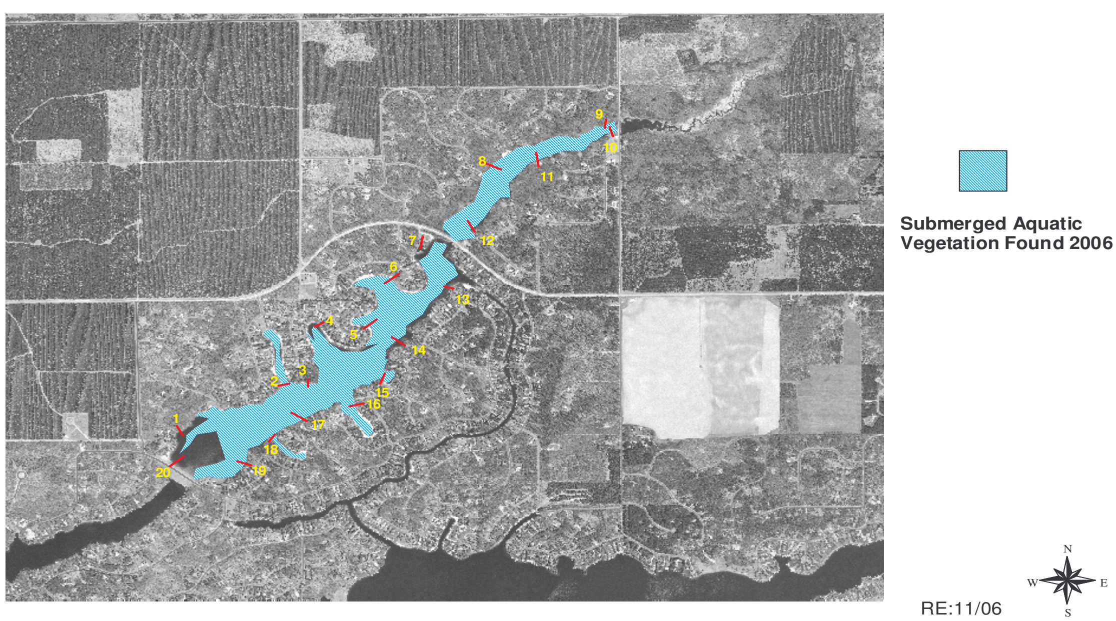
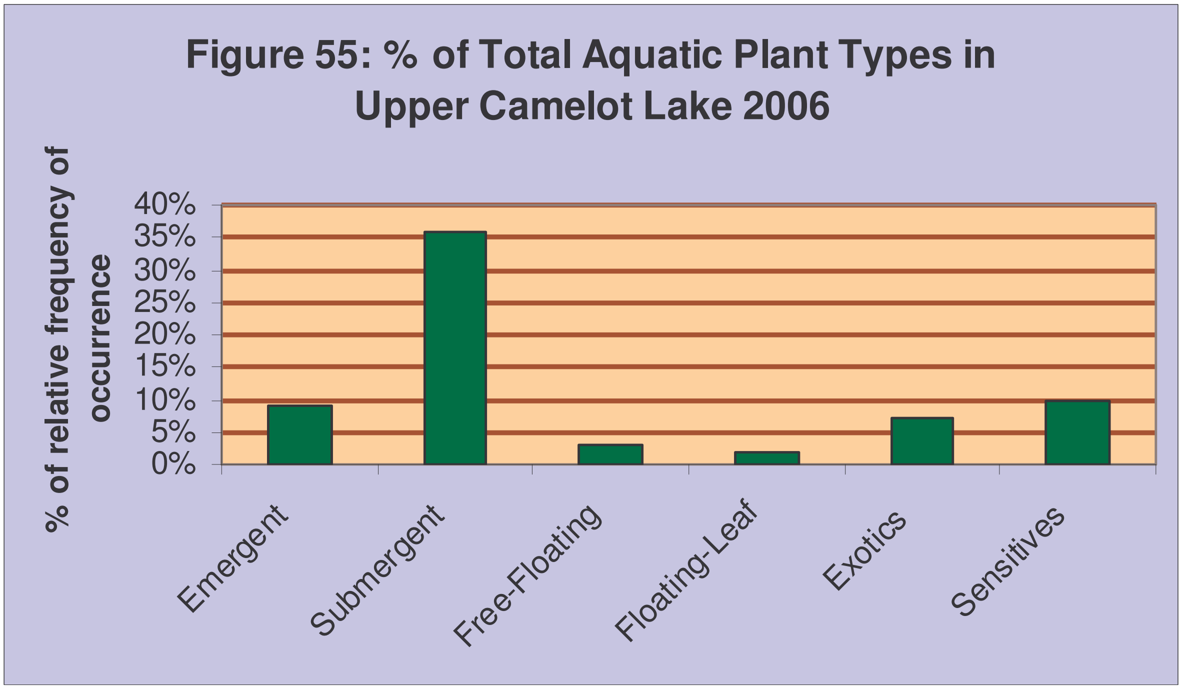


Figure 54b: Submergent Aquatics in Upper Camelot Lake 2006





CAMELOT CHANNEL

An aquatic plant survey was conducted by WDNR staff in 2000. This survey found that 90% of the sample sites in the channel were vegetated with aquatic plants, with the 0-1.5' depth supporting the highest mean number of species per site. The plant-like algae, *Chara* spp (muskgrass),was the most frequently-occurring aquatic "plant" species in the Camelot channel, followed by *Najas flexilis.* Only *Chara spp.* occurred at more than 50% frequency, although *Najas flexilis* was close at 48.39%. *Chara spp* also had the highest density and was the only species occurring at more than average density. Other plants found in the channel included *Carex lacustris, Eleocharis acicularis, Eleocharis palustris, Elodea canadensis, Potamogeton nodosus, Potamogeton pectinatus, Potamogeton pusillus, Potamogeton zosteriformis, Typha angustifolia* and *Zosterella dubia.* In addition, two invasives, *Myriophyllum spicatum* (Eurasian watermilfoil) and *Phalaris arundinacea* (Reed Canarygrass) were found in 2000, although neither of them occurred at high frequency, density or dominance.

Camelot Channel is a narrow channel connecting two lakes that are the first a series of impoundments that are originally fed by a very large, multi-county stream system. The channel is shallow, with a maximum depth of about 13'. With fair water clarity and shallow depths, plant growth may be favored in the Channel, since the sun reaches much of the sediment to stimulate plant growth.

Some type of naturally vegetated shoreline covered only 11.0% of the lake shoreline in 2006, down substantially from 2000, when it covered 38.5%. In both years, disturbed shorelines—including bare sand, traditional cultivated lawn, hard structure (piers, decks, seawalls, etc.) and rock riprap--were the most frequently-occurring. Overall, they covered 89.0% of the shore of Camelot Channel in 2006, up from 61.5% in 2000.

Of the 28 species found in the Camelot Channel, 25 were native and 3 were exotic invasives. In the native plant category, 9 were emergent, 1 was a floating-leaf plant, and 15 were submergent species. Three exotic invasives, *Myriophyllum spicatum* (Eurasian Watermilfoil) , *Phalaris arundinacea* (Reed Canarygrass) and *Potamogeton* crispus (Curly-Leaf Pondweed) were found. Filamentous algae were found at 25.58% of the sample sites in 2006 and at 33.33% of the sites in 2000.

Comparing the species found in 2006 to those reported in 2000, some changes are evident. Plants found in 2006 that were not found in 2000 included: *Impatiens capensis* (emergent); *Leersia* oryzoides (emergent); *Polygonum amphibium* (floating-leaf); *Potamgeton amplifolius* (submergent); *Potamogeton cripus* (submergent); Potamogeton *gramineus* (variable-leaf pondweed); *Potamogeton illinoensis* (emergent); *Sagittaria* spp (emergent); *Salix* spp (emergent); *Scirpus* validus (emergent); *Sparganium* spp (emergent); *Vallisneria americana* (submergent); and *Wolffia columbiana* (free-floating). Since the 2006 plant survey was conducted in August, past the prime growing season for *Potamogeton crispus*, it is possible that *P. crispus* was present earlier in the summer in 2006, since it was found in 2000.

Of the plants on this list, several are species likely to increase in frequency and/or density in the case of regular drawdowns: *Carex spp* (emergent); *Leersia oryzoides* (emergent); *Najas flexilis* (submergent); *Potamogeton crispus* (submergent exotic); *Potamogeton pectinatus* (submergent); *Scirpus validus* (emergent) and *Potamogeton zosteriformis* (submergent). Some also tend to decrease with regular drawdowns: *Chara spp* (submergent); *Myriophyllum sibiricum* (submergent); *Myriophyllum spicatum* (submergent exotic); and *Vallisneria americana* (submergent). In general, regular drawdowns will tend to encourage the increase of plants that can survive frequent disturbances.

Najas flexilis was the most frequently-occurring plant in Camelot Channel in 2006 (with 93.55% occurrence frequency), followed by *Myriophyllum spicatum* at 61.29 % occurrence frequency. In 2000, *Chara* spp. was the most-frequency occurring species, with *Myriophyllum spicatum* second with 48.39% occurrence frequency. No other species reached a frequency of 50% or greater in the lake overall in either 2000 or 2006.

Figure 56: Aquatic Plants in Camelot Channel

Scientific Name	Common Name	Type	Found in 2000
Carex spp	Sedges	Emergent	x
Ceratophyllum demersum	Coontail	Submergent	x
Chara spp	Muskgrass	Submergent	x
Eleocharis acicularis	Needle Spikerush	Emergent	x
Elodea canadensis	Waterweed	Submergent	x
Impatiens capensis	Jewelweed	Emergent	
Leersia oryzoides	Rice Cut-Grass	Emergent	
Myriophyllum sibiricum	Northern Milfoil	Submergent	
Myriophyllum spicatum	Eurasian Watermilfoil	Submergent	x
Najas flexilis	Bushy Pondweed	Submergent	x
Phalaris arundinacea	Reed Canarygrass	Emergent	x
Polygonum amphibium	Water Smartweed	Floating-Leaf	
Potamogeton amplifolius	Large-Leaf Pondweed	Submergent	
Potamogeton cripus	Curly-Leaf Pondweed	Submergent	
Potamogeton foliosus	Leafy Pondweed	Submergent	x
Potamogeton gramineus	Variable-Leaf Pondweed	Submergent	
Potamogeton illinoensis	Illinois Pondweed	Submergent	
Potamogeton nodusus	Long-Leaf Pondweed	Submergent	x
Potamogeton pectinatus	Sago Pondweed	Submergent	x
Potamogeton pusillus	Small Pondweed	Submergent	x
Potamogeton zosteriformis	Flat-Stem Pondweed	Submergent	x
Sagittaria spp	Arrowhead	Emergent	
Salix spp	Willow	Emergent	
Scirpus validus	Soft-Stem Bulrush	Emergent	
Sparganium spp	Burreed	Emergent	
Typha angustifolia	Narrow-Leaf Cattail	Emergent	x
Vallisneria americana	Water Celery	Submergent	
Wolffia columbiana	Watermeal	Free-Floating	

Najas flexilis was also the densest plant in 2006 in Camelot Channel, with a mean density of 2.94 (on a scale of 1 to 4). In the lake overall, it was the only species of aquatic vegetation that had a mean density of over 2.0, meaning it occurred at more than average density, in 2006. In 2006, it was the only species that occurred at more than average density in Depth Zones 1 and 2.

However, when looking at the "mean density where present", more plants had a more than average density in 2006: in addition to *Najas flexilis, Chara* spp*, Polygonum amphibium, Potamogeton amplifolius* and *Vallisneria americana* all had higher than average densities of growth where they were present. These figures indicate some areas in the lake have higher than average density growth form that can interfere with fish habitat and recreational use. In 2000, only three species occurred at more than average density where present than in 2006: *Chara* spp., *Najas flexilis,* and *Potamogeton nodusus.*

Relative frequency and relative density are combined into a dominance value that demonstrates how dominant a species is within its aquatic plant community. Based on dominance value, *Najas flexilis* was the dominant aquatic plant species in Camelot Channel in 2006. *Chara* spp dominated the aquatic plant community of Camelot Channel in 2000.

The Simpson's Diversity Index for Camelot Channel in 2006 was .91, indicating good species diversity. A rating of 1.0 would mean that each plant in the channel was a different species (the most diversity achievable). This places it in the upper quartile for Simpson's Diversity Index readings for both North Central Hardwood Forest Region and all Wisconsin lakes. The 2006 AMCI for Camelot Channel is 52, placing its quality in the average range for North Central Wisconsin Lakes and all Wisconsin Lakes. The AMCI value for 2000, 45, was below the state average.

Figure 57: AMCI Comparison Camelot Channel

	2006	2006	2000	2000
		Value		Value
Max. Rooting Depth	10.5'	5	13'	7
% Littoral Vegetated	96.80%	10	90.30%	10
% Submersed Spec.	87%	9	87%	9
% Exotic Species	13%	4	13%	4
% Sensitive Spec	10%	6	2%	3
Simpson's Index	0.91	9	0.85	6
Taxa #	25	9	13	6
		52		45

The presence of several invasive, exotic species could be a significant factor in the future. Currently, *Myriophyllum spicatum* had an occurrence frequency over 60%, despite the long history of both chemical and mechanical control efforts. This plant must continue to be monitored, since its tenacity and ability to spread to large areas fairly quickly could make it a danger to the diversity of Camelot Channel's current aquatic plant community. *Potamogeton crispus* was found in Camelot Channel in 2006, but not found in the 2000 survey. Since the 2006 survey was conducted in August, it is possible that some of the *Potamogeton crispus* that had simply died off by then, since *P. crispus* tends to be an early-season plant. The channel should also be further monitored for this invasive.

The Average Coefficient of Conservatism in the Camelot Channel in 2006 was 4.68 and 4.38 in 2000. This puts the channel in the lowest quartile for Wisconsin Lakes (average 6.0) and for lakes in the North Central Hardwood Region (average 5.6). The aquatic plant community in the Camelot Channel is in the category of those very tolerant of disturbance, probably due to selection by a series of past disturbances and current heavy shore development.

The Floristic Quality Index of the aquatic plant community in the Camelot Channel of 21.96 in 2006 is just below average for all Wisconsin Lakes (average 22.2) and just above the average for the North Central Hardwood Region (average 20.9). This suggests that the plant community in Camelot Channel is about as far from an undisturbed condition as the average lake in Wisconsin overall and in the North Central Hardwood Region. However, the Floristic Quality Index has increased between 2000 and 2006, suggesting some small progress in overall aquatic plant health may be occurring. Using either the Average Coefficient of Conservatism or the Floristic Quality Index scales, the aquatic plant community in Camelot Channel apparently has impacted by a more than average amount of disturbance..

Figure 58: Changes in Aquatic	**Plants**	**Camelot**	**Channel**	
Camelot Channel	2000	2006	Change	%Change
Number of Species	13	25	12	**92.31%**
Maximum Rooting Depth in Feet	13.0	10.5	-3	**-19.23%**
% of Littoral Zone Unvegetated	9.70%	3.20%	-0.065	-67.01%
%Sites/Emergents	10.13%	5.81%	0.0	-42.65%
%Sites/Free-floating	0.00%	3.87%	0.0	**3.87%**
%Sites/Submergents	89.87%	90.32%	0.0	**0.50%**
%Sites/Floating-leaf	0.00%	1.00%	0.0	
Simpson's Diversity Index	0.85	0.91	0.06	**7.06%**
Species Richness	2.82	5.17	2.35	**83.33%**
Floristic Quality	15.81	21.96	6.15	**38.90%**
Average Coefficient of Conservatism	4.38	4.68	0.30	**6.85%**
AMCI Index	45	52	7.00	**15.56%**

Further, when calculating the coefficient of similarity between the 2000 and 2006 surveys, they score as statistically dissimilar. Based on frequency of occurrence, the aquatic plant communities of the two years are only 45% similar. Similarity percentages of 75% or more are considered statistically similar; obviously, the Camelot Channel percentages are far from that. Emergent vegetation (an important habitat component) has decreased by nearly one-half, and floating-leaf vegetation is very sparse. Disturbance indicator, *Chara*, has decreased substantially, but another disturbance indicator, *Najas flexilis*, has increased, as has *Myriophyllum spicatum* (Eurasian Watermilfoil).

Figure 59: Common Native Aquatic Species in the Camelot Lakes

Najas flexilis
(Bushy Pondweed)

***Chara* spp**
(Muskgrass)

Vallisneria americana
(Water Celery)

MANAGEMENT RECOMMENDATIONS

(1) Because the plant cover in the littoral zones of both lakes and the channel are over the ideal (25%-85%) coverage for balanced fishery and there are some areas with more than average plant density, continued harvesting to open fishing lanes should occur in some areas. Plant removal should occur by hand in the shallower areas to be sure that entire plants are removed and to minimize the amount of disturbance to the sediment.

(2) Natural shoreline restoration and erosion control in many areas is needed, especially on some bare steep banks. If trees fall at the eroded sites due to continued erosion, large portions of the banks will fall with them.

(3) To protect water quality and preserve shorelines, a buffer area of native plants needs to be restored on those many sites that now have seawalls or have traditional lawns mowed to the water's edge. Large areas of the lake shoreline are unnatural and prone to erosion & runoff of nutrients & toxics. Unmowed native vegetation reduces runoff into the lake and filters runoff that enters the lake.

(4) The Tri-Lakes Management District and the Camelot Lake Association should continue to cooperate with the WDNR to monitor for the introduction of zebra mussel to protect the aquatic plant community in the lakes & channel.

(5) To improve water quality, the following actions should be considered:
  (a) The groundwater study indicated nutrients are coming from shoreline properties. To improve water quality, stormwater management of the many impervious surfaces around the lake is essential to maintain the current quality of the lake water and prevent further degradation.
  (b) No lawn chemicals should be used on properties around the lake. If they must be used, they should be used no closer than 50' to the shore.
  (c) No broad-scale chemical treatments of aquatic plant growth are recommended due to the undesirable side-effects of such treatments, including increased nutrients from decaying plant material and decreased dissolved oxygen and opening up more areas to the invasion of EWM.
  (d) No drawdowns of water level except for DNR-approved purposes should occur. Several of the plants found in the lakes & channel are those encouraged by drawdowns.
  (e) The few sites where there is undisturbed shore should be maintained and left undisturbed.

(6) The aquatic plant management plan should be reviewed annually. Mechanical harvesting plans should continue target harvesting for Eurasian Watermilfoil (EWM) and include target harvesting for Curly-Lead Pondweed to prevent further spread. Mechanical harvesting must follow the approved Lake Management Plan.

(7) The Camelot Lake Association may want to continue to apply for grants from the Wisconsin Department of Natural Resources to help defray the cost of aquatic plant management.

(8) Any fallen trees should be left in the water

(9) The Tri-Lakes Management District conducted water quality monitoring for several years, but has decreased its involvement during 2004-2006 when Adams Land & Water Conservation Department was doing more intense monitoring as part of a Lake Classification Grant. Water quality monitoring by the Lake District or through the DNR Self-Help Monitoring Program should be restarted.

(10) Upper Camelot Lake residents should identify, cooperate with and participate in watershed programs that will reduce nutrient and sediment inputs.

(11) The Tri-Lakes Management District should make sure that its lake management plan takes into account all inputs from the these lakes' surface ground watershed, and addresses the concerns of this larger lake community.

(12) Pursue installation of sewage system around the lake to reduce nutrient input from the lakeshores. Reduction of nutrient inputs by residents around the lakes and channel needs to occur before asking watershed residents to reduce theirs.

Aquatic Invasives—Plants

The Camelot Lakes have four known invasive aquatic plant species: Curly-Leaf Pondweed (submergent); Eurasian Watermilfoil (submergent); Purple Loosestrife (emergent) and Reed Canarygrass (emergent). These lakes are heavily-trafficked by both lakeshore landowners and outside day-users. The Tri-Lakes Management District has a lake management plan that includes management of aquatic invasives. The lake has been using targeted harvesting for Eurasian Watermilfoil, emphasizing the harvesting of that plant in May and September, while harvesting the summer months for navigation, rather than control of Eurasian Watermilfoil. In 2007, several lake citizens were trained to monitor the aquatic invasives and participate in the Clean Boats, Clean Waters boater education program.

Figure 60: Distribution of Exotic Aquatic Plants in Lower Camelot Lake 2006

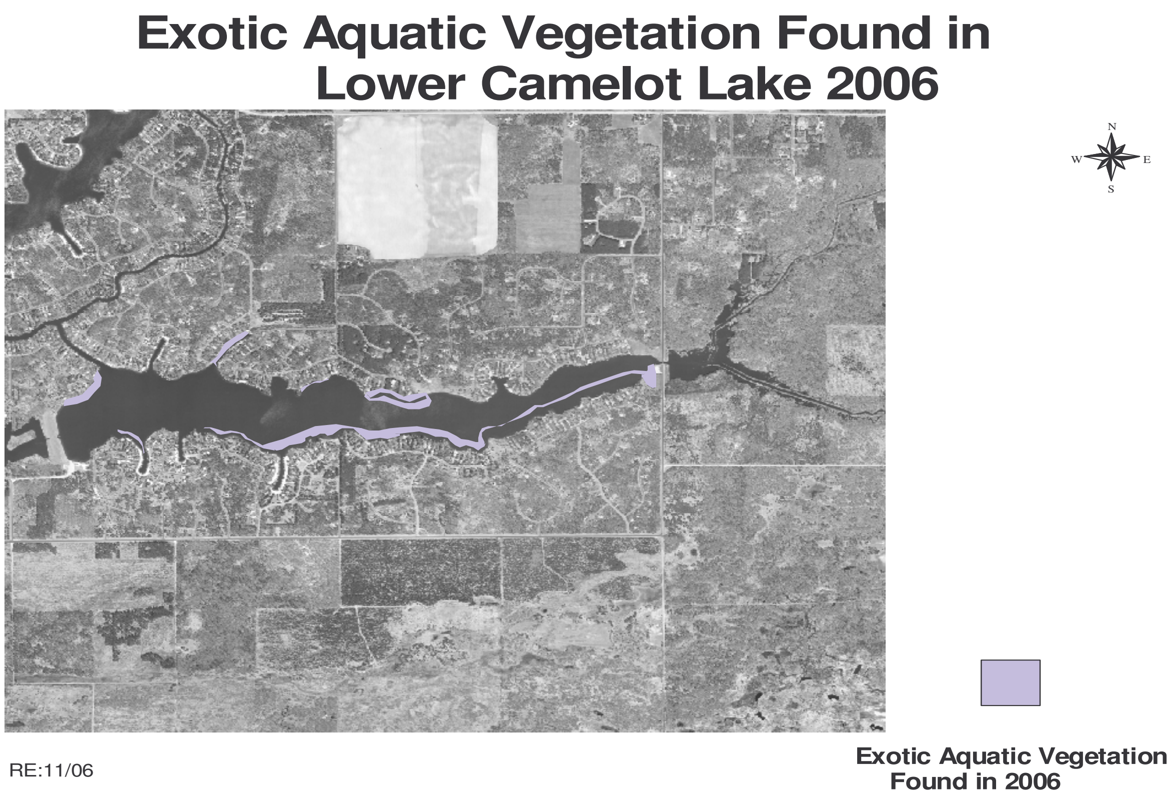


Figure 61: Exotic Aquatic Plants in Upper Camelot Lake 2006

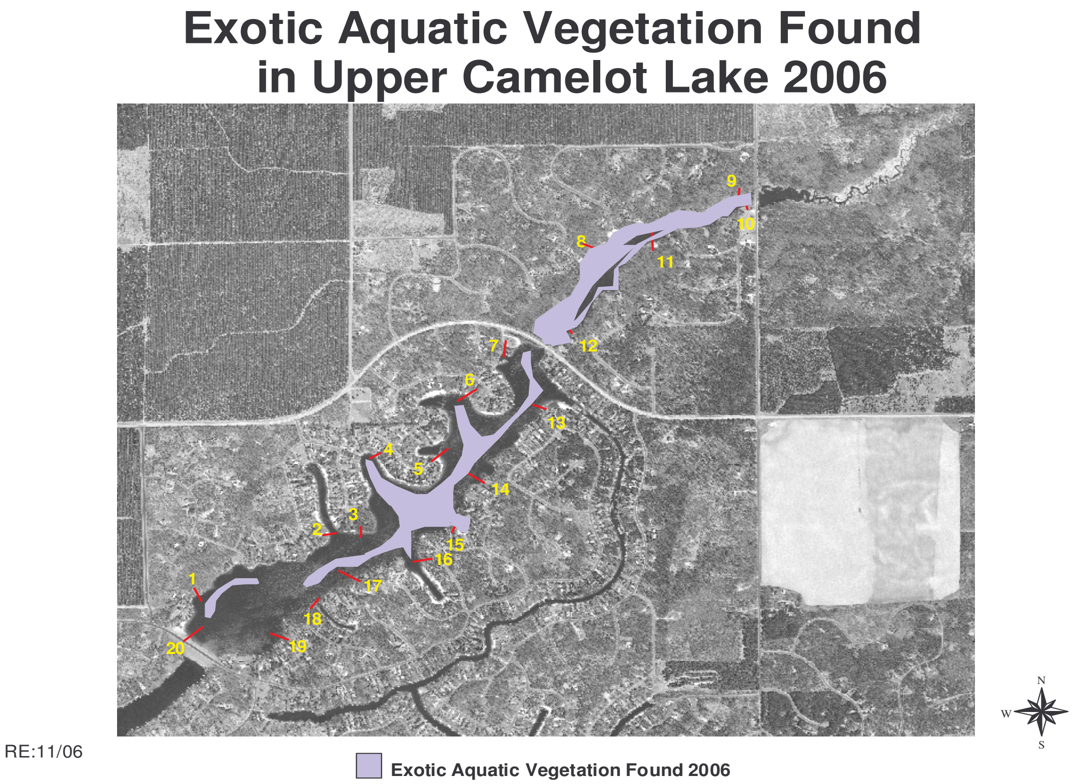


Figure 62: Invasive Aquatic Plants in Known in the Camelot Lakes & Channel

Curly-Leaf Pondweed

Eurasian Watermilfoil

Reed Canarygrass

Purple Loosestrife

Aquatic Invasive—Animals

Arrowhead Lake, the last lake in the Tri-Lakes, is currently the only in-land lake in Adams County known to have zebra mussels. They are also found in the Wisconsin River and in both Castle Rock and Petenwell Lakes on the western edge of Adams County.

The WDNR has been monitoring Arrowhead Lake, as well as Sherwood Lake, Lower Camelot Lake, and Upper Camelot Lake since the zebra mussels were discovered in Arrowhead and works with the Tri-Lakes Management District to try to manage the mussels on that lake and prevent a spread of the mussels to the other Tri-Lakes. Because of the presence of these mussels, participation in the Clean Boats, Clean Waters program is especially urgent.

Figure 63: Zebra Mussels

Rusty Crayfish are also known to be in the Tri-Lakes system in all three lakes, but do not appear to have reached a level to cause any significant impact at this time. They should be monitored, so that if they appear to be increasing in presence, action can be taken to manage them. Unchecked, rusty crayfish can seriously damage a lake's ecosystem, destroying many of the aquatic plants on which fish & their prey depend, and ultimately negatively affecting the fish population.

Figure 64: Rusty Crayfish

FISHERY/WILDLIFE/ENDANGERED RESOURCES

The most recent fishing inventory of the Camelot Lakes, in 2002, showed that bluegills, largemouth bass and yellow perch were abundant. Crappies, northern pike and walleyes were present, but scarce. In the past, bullheads, golden shiners, pumpkinseeds and white suckers have also been found in the lake, as have carp. There was a chemical kill of fish on the Tri-Lakes in 1967 to deal with carp. There is also a history of fish kills from the *Columnaria* bacteria (a native bacteria). WDNR stocking records indicate stocking of bluegills, largemouth bass, northern pike and walleye in the past.

Muskrats have been seen on these lakes. Seen during the field survey were various types of waterfowl and songbirds. Frogs and salamanders are known, using the lake shores for shelter/cover, nesting and feeding. Turtles and snakes also use this area for cover or shelter in this area, as well as nested and fed in this area. Upland wildlife feed and nest here as well.

Figure 65: Yellow Perch, an Abundant Fish in the Camelot Lakes

There are endangered resources known to be in the Camelot watersheds. The long-leaved aster (*Aster longifolius*) is the only special plant reported there, but there are three butterflies, a leafhopper and a bird also known to be there. The butterflies are the Gray Copper butterfly (*Lycaena dione*), the Karner Blue Butterfly (*Lycaedides melissa samuelis*), and the Regal Fritillary butterfly (*Speyenia idalia*). The Greater Prairie Chicken (*Tympanuchus cupido*) has booming grounds in the eastern part of the watersheds. A leafhopper (*Graphocephala* spp) has also been reported in these watersheds.

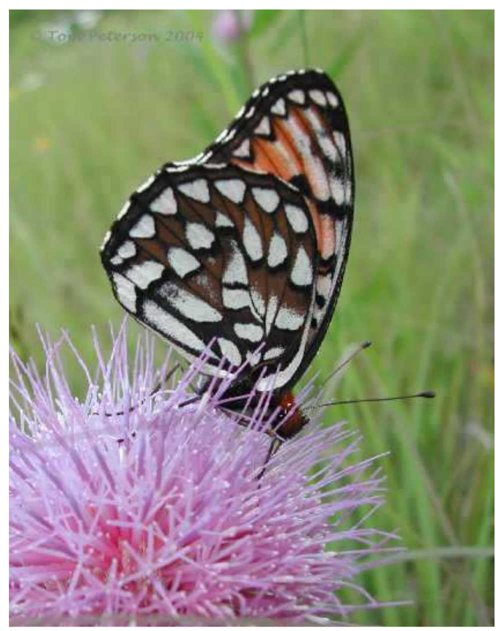
KARNER BLUE BUTTERFLY

GREATER PRAIRIE CHICKEN

Figure 66: Photos of some of the species of concern in Camelot Lakes Watersheds*

*information courtesy of Wisconsin Department of Natural Resources

Large-leaved Aster



Regal Fritillary

RESOURCES

Bell, R.A. 2000. Phytoplankton Community Composition and Distribution in the Tri-Lakes Area. UW-Stevens Point.

Bryan, B., B. Charry. 2006. Conserving Wildlife in Maine's Shoreland Habitats. Maine Audobon Society.

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology and Oceanography 22:361-369.

Comas, S.R. 1993. Tri-Lakes, Adams County, Wisconsin Lakes & Watershed Characterization. Blue Water Science, St. Paul, Minnesota.

Dennison, W., R. Orth, K. Moore, J. Stevenson, V. Carter, S. Kollar, P. Bergstrom, R. Batuik. 1993. Assessing Water Quality with Submersed Vegetation. Bioscience 43(2):86-94.

Engel, S. 1985. Aquatic Community Interactions of Submerged Macrophytes. Wisconsin Department of Natural Resources Bulletion #156.

Frankenberg, J. Land Use and Water Quality. Purdue Extension Publication ID-230.

James, T. 1992. A Guidebook for Lake Associations. The International Coalition for Land and Water Stewardship in the Red River Basin, Minnesota.

James, W.F., J. Barko & H. Eaken. 2002. Limnological Investigations of Camelot, Sherwood, & Arrowhead Lakes, WI. U.S. Army Corps of Engineers, Spring Valley, WI.

Kibler, D.F., ed. 1982. Urban Stormwater Hydrology. Water Resources Monograph 7. American Geophysical Union.

Krysel, C, E.M. Boyer, C. Parson, P. Welle. 2003. Lakeshore Property Values and Water Quality: Evidence from Property Sales in the Mississippi Headwaters Region. Report to the Legislative Commission on Minnesota Resources.

Lillie, R.A., J.W. Mason. 1983. Limnological Characteristics of Wisconsin Lakes. Department of Natural Resources Bulletin No. 138.

MSA Professional Services. 1999. Septic Study of Tri-Lakes.

Nichols, S. 1998. Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications. Journal of Lake and Reservoir Management 15(2):133-141.

Nichols, S., S. Weber, B. Shaw. 2000. A Proposed Aquatic Plant Community Biotic Index for Wisconsin Lakes. Environmental Management 26(5): 491-562.

Shaw, B., C. Sparacio, J. Stelzer, N. Turyk. 2001. Assessment of Shallow Groundwater Flow Chemistry & Interstitial Water Sediment, Aquatic Macrophyte Chemistry for Tri-Lakes, Adams County, WI. UW-Stevens Point.

Shaw, B., C. Mechanich, L. Klessing. Understanding Lake Data. UW-Extension Publication SR-02/2002-1M-525, 2000.

Terrell, C., P. Perfetti. 1989. Water Quality Indicators Guide: Surface Waters. United States Department of Agriculture Publication SCS-TP-161.

University of Wisconsin-Madison Water Resources Management Program. 1978. Fourteen Mile Creek Watershed: A Water Management Study. UW-Madison.

Wagner, C., J. Haack, R. Korth. Protecting Our Living Shores. 2003. Shoreland Stewardship Series #3 WDNR Publication WT-764-2003. UW-Extension, Wis. Lakes Partnership, WDNR, Wisconsin Association of Lake & River Alliance of Wisconsin.

Figure 67: Camelot Lake in the Fall